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NOTES AND COMMENTS.

Employment in the Foundry Trades.

The first part of Volume X. of the Census of England and Wales for 1911 was published last month, and contains some interesting figures relative to the engineering and other trades. Somewhat fuller information than formerly was collected in 1911, and the resulting changes in classification have affected the figures under some heading to an extent which it is impossible to estimate, and have to be taken into account in comparing the numbers in 1901 and 1911 of workers in iron and steel. The 1911 figures of particular interest to the foundry trade are as follows:—

	Persons.	Males.	Females.
Pig-iron manufacture (blast furnaces)	21,698	21,698	—
Steel-manufacture, smelting and founding	39,588	39,555	33
Ironfounders	102,513	102,191	322
Included under Ironfounders:—			
Moulders, core-makers	57,065	56,784	281
Foundry labourers	30,666	30,666	—
Fettlers	8,526	8,520	6
Cupola and oven men	2,506	2,506	—
Others and undefined	3,750	3,715	35
Brassfounders	12,074	12,034	40
Patternmakers	14,025	14,025	—

In addition there were 10,261 stove, grate, range and fire-iron makers (9,819 males and 442 females) not included in the above. The heading "Ironfounders, which was given for the first time in 1901, then included 100,217 males, and in 1911 the number had increased only to 102,191, or by 2.0 per cent. The recorded increase, however, falls short of the actual increase. For although, on the one hand, the 1911 total includes a number of labourers who would not have been included in 1901 on account of indefinite returns, yet, on the other hand, the 1901 total includes a much larger number of men who, owing to the more precise returns in 1911, are now included under the headings for their special products, since the additional information as to the nature of the employer's business furnished has enabled more of the ironfounders employed in various manufactures (stoves and grates for example), to be shown under the heading for those manufactures than was formerly the case. The term "foundry" is used, especially in some parts of the country, to describe general engineering works, and the difficulty of classifying ironfounders in such districts was met to some extent by sending inquiries to the local registrars and tabulating according to the information received. Notwithstanding the difference of classification, there were considerable increases under the heading "Ironfounders" in some counties, though in Lancashire, where the largest numbers were enumerated, there was a decrease. The largest numbers were returned in the following counties:—Lancashire, 26,638; Yorkshire (West Riding), 15,708; Staffordshire, 8,798; Derbyshire, 6,093; Durham, 5,361. The whole of the increase under this heading occurred at the age-groups 25 and upwards. In addition to the 102,191 males classified as "ironfounders," there were 18,081 males connected with general iron-

founding businesses; these included 4,395 erectors, fitters, turners, and their labourers, 2,776 blacksmiths and strikers, 1,805 metal machinists, 1,342 pattern-makers, 1,197 engine drivers, stokers and firemen (not railway), 1,982 commercial clerks, 864 carmen, etc., and 553 messengers, porters and watchmen. On the other hand, in addition to the ironfounders included in the occupation tables under the various manufactures with which they were connected, a further 31,040 are shown not to be employed in ironfounding businesses, this total including 26,559 employed in Government, railway and other engineering and machine-making works.

In regard to a comparison with the 1901 Census figures, there is some uncertainty in comparing the numbers at the two censuses under the several headings, not only on account of the undefined iron workers, but also from the possibility of differences of classification at the two censuses, owing to the actual overlapping of occupations coming under different headings. In some cases it was extremely difficult to distinguish between pig-iron manufacture and ironfounding carried on in proximity to it. Steel-manufacture, smelting, and founding, gave employment to 17,713 males in Yorkshire, West Riding (against 10,896 in 1901), to 3,906 in Yorkshire, North Riding, to 3,818 in Glamorganshire, and to 3,611 in Durham.

It may also be of interest to state that in the administrative county of London the figures, divided into (1) employers, (2) working for employers, and (3) working on own account, were as follows in the census year:—

	Employers.	Working for employers.	Working on own account.
Steel-manufacture, smelting and founding	9	112	—
Ironfounders	38	2,310	2
Brassfounders	36	1,263	19
Patternmakers	14	590	28
Stove, grate, range and fire-iron makers	16	492	9

There were also 93 ironfounders, 25 brassfounders, and 24 patternmakers who were not distinguished as above, and 8 female employés in ironfounding. There were further 11 stove, grate and range makers not distinguished.

Foundry Accidents in 1913.

The annual report of the Chief Inspector of Factories and Workshops shows that last year the trade continued to take serious toll of its workers. There were in all during the year 8,307 accidents, of which 20 were fatal, the total including 835 (8 fatal) from machinery moved by mechanical power, 2,972 (one fatal) by molten metal, 39 (one fatal) by explosion, 38 by escapes of gas or steam, 8 by electricity, 86 (two fatal) from hand cranes, two with hand presses, 14 with other hand-driven machinery, 1,237 (five fatal) struck by falling bodies, 517 (three fatal) by persons falling, 195 struck by tools in use, and 2,364 from other causes.

That the authorities are somewhat alive to the necessity of reducing this serious list of accidents is evidenced by the various meetings between representatives of the Factory Department and associations of employers and operatives in the iron-founding trades, which have been held to discuss safety precautions. A report on such conferences concerning safeguards for the prevention of accidents in iron foundries, it will be remembered, was issued by Mr. G. Bellhouse, H.M. Superintending Inspector of Factories, early this year (see "F.T.J.," February, 1914). The agreements were not very far-reaching, for it was found that there was great divergence of opinion on several of the points at issue, not merely between parties represented at the conference, but also amongst the operatives themselves, and to a lesser extent amongst the employers. Points dealing with the lighting of foundries have been postponed in consequence of the appointment of a Departmental Committee to consider the question of lighting in factories and workshops generally. It has been proposed that additional rules should be included in contemplated Regulations to deal with certain proposals in respect of which no agreement was reached, but which received a considerable measure of support. The most important of these is the provision of protection for the feet, for an analysis of the accidents in 1912 shows that of 2,559 molten-metal accidents, no fewer than 1,781 accidents caused injury to the leg or foot. These figures suggest that a real reduction of accidents might be attained by the use of special boots, spats, or other forms of foot protectors, such as are already voluntarily provided by some employers.

It is encouraging to note that attempts have been made in all districts to secure the adoption of the safety precautions recommended by the Departmental Committee on Accidents and other points discussed at the Ironfoundry Conference. Some progress is reported, though little improvement can yet be noted in the reduction of burning accidents to the feet, due to spills of molten metal, many of which would be prevented by the use of special boots, leggings, or spats. The experience of a large engineering firm in Dublin suggests that the spilling of metal may be due to exhaustion through carrying ladles for long distances. The firm has recently adopted the system of carrying metal from the cupolas to the casting shops on bogies, thus reducing the distance of hand carrying. No foot burns have occurred since the change, though the working conditions are otherwise the same. Special attention has been given to the subject of boot protectors in the Midland Division, and in every case where burns to the feet have occurred through the escape of molten metal, a notice has been sent to the employer urging the provision of these safeguards. One firm who provide boot protectors free of charge, require the foundry foreman to make an inspection each week of all boots worn by the foundry employés and to issue the leather guards to all who need them. Mr. Crampton (Stirling), reporting on the light casting foundries in his district, says:—"The roadways for conveying molten metal are, as a rule, kept in good order; there is some slackness in allowing water to lie about the floors, and in one case the uneven manner in which the bogie rails were laid suggested the probability of jolting and splashing. In another foundry the space between the cupolas and the moulding shops was not under cover, and the ground at this point was bound to be damp in wet weather, with greater risk of accident in the event of any spilling from the bogies."

The dust question also represents a serious problem in foundry work. The Inspector of the Northern Division states that early in 1913 the prevention of dust in various departments of iron foundries was discussed at Falkirk with representative employers, and it was agreed that steps should be taken to improve the conditions in dressing, grinding, and fitting shops. Satisfactory arrangements have already been installed in some of the foundries, and before long it is hoped that all principle machines will be dealt with. Experiments are also to be tried to devise means for carrying off dust generated by the hand-brushing of castings, as this operation frequently leads to most undesirable conditions. Meanwhile some effort is being made to keep floors cleaner so as to reduce the dust stirred up by movements of the workers.

The Works of the Atlas Steel Foundry and Engineering Company, Limited.

The Atlas Steel Foundry and Engineering Company, Limited, was incorporated in May, 1912. The works, which were built by the Company, are situate at Armadale, Linlithgowshire, about 23 miles from Glasgow, and 21 miles from Edinburgh, on the North British Railway. The management is vested in Mr. D. M. Cunningham (director and general manager) and Mr. C. King (director and assistant general manager), whilst the secretarial duties are discharged by Mr. James M. Watt. The Company have been placed upon the Admiralty, Lloyds, British Corporation, and Crown Agents' lists, the works being devoted to the production of high-class steel castings up to ten tons in weight, for the shipbuilding and general engineering industries. A speciality, however, is made of cast gears and gear blanks, whilst on the engineering side they are developing specialities for colliery requirements.

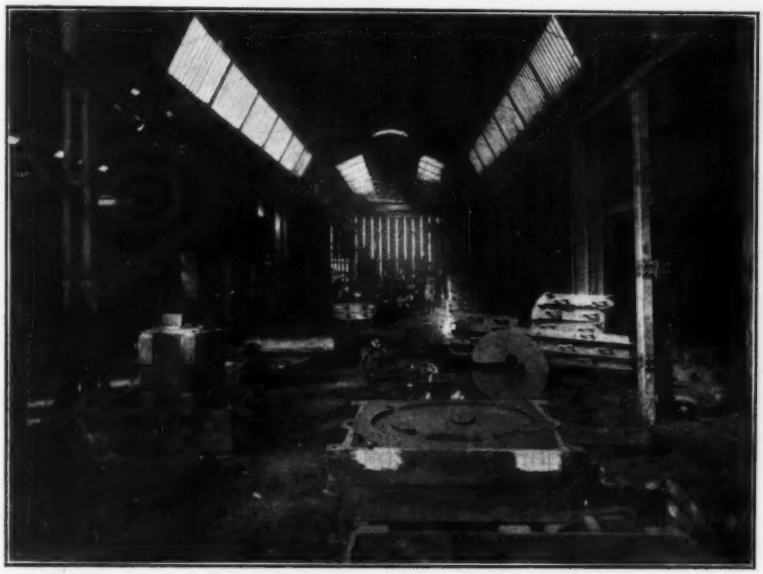

Fig. 1.—View in Atlas Steel Foundry.

Sidings from the North British Railway serve both sides of the works, on the one hand to bring in the raw material and on the other to take out the finished work. The works have been laid down with a view to future extensions, and as a matter of fact it has already been found necessary to extend the central bay of the moulding shop by an additional 111 ft.

The moulding shop is a brick building 270 ft. 6 in. long, with a central bay 32 ft. and two side bays 159 ft. long by 23 ft. wide. The floor of the main bay, which is devoted to the heavier work, is served by a 15-ton and a 10-ton electric crane, the first-named a Marshall-Flemming and the latter a Chambers-Scott. Included in the moulding-shop equipment are two wheel-moulding machines capable of taking gear wheels up to 10 ft. in diameter.

There are four core-drying ovens, arranged in pairs, each pair being heated by an independent producer. The producers are of the "Adelphi" type, a comparatively recent introduction, designed and built by Messrs. Muir, Murray & Company, Paisley, N.B., who also erected the ovens. The carriages are of the rolling-axle type. The stove doors are of composite asbestos, and may easily be operated by a boy. The producers, which are placed immediately outside the stove walls, so that there is a minimum loss of sensible heat between them and the stoves, are of a type very easily managed, only requiring cleaning once in 24 to 48 hours, and if charged at 5.30 p.m. will carry on till 6 a.m. On this system there is no smoke nor soot, which fact, of course, adds to the comfort of the conditions of working in the foundry.

A continuation of the moulding shop consists of two bays 110 ft. by 24 ft. and 136 ft. by 25 ft. span respectively. Within the first bay is the Siemens furnace of a capacity of 10 to 12 tons. The charging platform, which is reached by an inclined way from the foundry floor, is 48 ft. by 25 ft. The furnace is provided with two gas producers, each 9 ft. in diameter. These were designed and built by the Company, and are served with a charging platform 29 ft. by 17 ft. The producer platform and the furnace platform are at truck level and placed on either

side of the line of track by which the raw materials are delivered, so that the trucks are discharged direct at the point of consumption, and a second handling of material is avoided. Stevenson's casting ladles are employed throughout. The plant is served by a stack 120 ft. high by 8 ft. in diameter at the top.

The sand house is a brick building 44 ft. long, with compartments for various sands. The core house is provided with a sand mixer and a pan mill driven by 10-ton Chambers-Scott electric crane. Within the shop are two annealing ovens each 12 ft. by 8 ft. 7½ in. Each furnace is capable of taking 15 tons of castings, which are carried on steel carriages, sand sealed at sides and back. A feature of the arrangement is that after the castings in one furnace have been annealed, the other furnace is charged, and by means of a special provision of waste-gas flues, the waste heat from the oven cooling off is utilised in heating up the newly-charged oven. The steam to the producer—which is common to both ovens—is shut off meantime, and thereby effects a considerable saving in fuel. The heats are brought up from cold to 1,000 deg. C. in six hours, and the castings, which are clean and free from scale, give excellent test results. The complete plant was supplied by Messrs. Muir, Murray & Company. Hard by the annealing furnaces is a Tilgham's sand-blast apparatus, as also a very comprehensive installation of oxy-acetylene and electric cutting plants. The machinery, which includes a 42-in. vertical saw and a 32-in. horizontal saw, a planing machine and two double grinders, is driven by a 40-h.p. motor. Adjoining the fettling shop is the fitting shop, a building 121 ft. 3 in. by 57 ft. 9 in., the main bay being 30 ft. 9 in. and the side bay 24 ft. The main bay is served by a 10-ton electric crane. The tools installed include screw-cutting lathes, facing and boring, planing and slotting machines, a 14-in. high-speed saw, etc., the whole being operated from line shafting driven by a 40-h.p. motor. In this shop there are also a hand pump for hydraulic testing and a hydraulic press.

The smiths' shop, which is entered from the fitting shop, and is also in direct communication with the moulding shop, is 80 ft. by 30 ft. There are three hearths, each being provided with a separate motor-driven Keith-Blackman blower.

The pattern shop, which is an entirely independent building of brick with slate roof, is 60 ft. by 30 ft., and well equipped with the most modern type of wood-working machinery, amongst which mention may be made of the universal wood-working machine by Wadkin & Company, which is driven by an independent motor, surface planing machines, lathes, plane-grinding machine, a saw-sharpening machine, etc. The line shafting is driven by a 15-h.p. motor, which is installed at line-shafting level.

The pattern stores, another independent building, is 60 ft. by 26 ft., and consists of two flats, thus affording ample storage accommodation.

Fig. 2.—Pattern Shop: Atlas Steel Foundry.

The power house, which is situated on the north side of the works, is 40 ft. by 25 ft. The units installed comprise a Willans 400-kw. generator for power purposes, and a Willans 60-kw. generator for lighting; also a reversible motor generator by Bruce Peebles & Company, to work off either of the steam sets, as may be required.

There is also an Alley & MacLellan two-stage compressor which supplies air at 100 lbs. pressure for the sand-blast apparatus, and the pneumatic tools used throughout the works.

Steam is raised in a Babcock boiler fitted with superheater and provided with chain-grate automatic stoker. Feed water is taken from the town supply. The stack is similar to that for the furnace.

A further small building contains a well-equipped laboratory, where analyses are taken of all raw materials. Analyses and tests are also taken of every cast and careful records kept of the particular heat treatment.

Conveying Systems for the Foundry.

The importance of adequate and efficient transporting devices in the foundry is becoming better realised as a factor in economy, and modern foundry firms are giving the question careful attention. There are several distinct classes of conveying and transporting apparatus, each of which has its own special advantages. The system mentioned in the following description (taken from "The Iron Age") is an example of up-to-date American practice.

The foundry in question was recently constructed at the new South Works at Racine, Wis., U.S.A., of the J. I. Case Threshing Machine Company. The South Works plant is designed to produce the cast-iron parts for Case gas tractors and Case motor cars, and consists of a foundry, 174 ft. wide and 755 ft. long; a machine shop, 160 ft. wide and 750 ft. long; a four-storey building for the storage of materials held in stock, including raw materials, semi-finished castings in transit from foundry to machine shop and finished parts; and an electric power house and pumping station. In general the buildings are of heavy steel construction, carried on concrete foundations. The roof design of the foundry is a typical saw-tooth, affording a north light, provided with two ventilators on each ridge and a ventilating trap door at both ends of each roof segment.

On the east side the foundry building is flanked by a raw-materials storage yard of equal length with the foundry and 80 ft. wide, spanned by a 10-ton crane equipped with lifting magnet. On the opposite side of the foundry the 80 ft. of space intervening between it and the stock building serves as a storage yard for castings and raw materials for the tractors, and is likewise traversed by a 20-ton crane. Serving all parts of the foundry floor and connecting the foundry with both of the storage yards and also with the stock building, is a Shaw electric monorail system. This monorail system coupled with an elaborate installation of over-head, hand and electric-hoist cranes operating at right angles to the line of the monorail constitutes a distinctive feature of the plant. The general lay-out of the foundry and of the monorail and crane systems is shown in Fig. 2.

In the raw-materials storage yard the provisions made for storing and handling the coke, stone, scrap and pig-iron are apparent from the lay-out. For the storage of sand, concrete bins have been built, the floor of the bins being 10 ft. below the floor of the foundry and at a level with a sub-floor space under a portion of the core-making floor. With this basement the sand bins are connected by tunnel. An elevator of the hydraulic type raises the sand to the main floor. The sand bins are enclosed with a frame structure arranged with hatches in the roof and with apertures on the side so that the sand may be unloaded into the bins either by dropping from the crane or directly from box cars brought in on the track which traverses the storage yard and parallels the sand building.

The provisions for handling raw materials from the yard to the cupolas include an extension of the charging floor at a height of 25 ft. above the yard level and extending out under the crane about 17 ft. This platform is 160 ft. long and is divided into ten platform compartments, separated by 2-ft. partitions. The entire structure is of steel. The iron-melting plant of the foundry occupies a space centrally located in the east bay, 160 ft. long. Provision is here made for the installation of six cupolas, of which for the present two new 102-in. cupolas lined to 84 in. inside, are installed with a capacity of about 25 tons per hour, and two 84-in. cupolas, from the old foundry, lined to 66 in. inside and with an average capacity of 20 tons per hour. The melting capacity available is thus approximately 1,000 tons per day. The blowers are mounted on a mezzanine floor at a height of 14 ft. above the main foundry floor, and consist of a No. 7½ Roots blower driven by a 75-h.p. motor for the two new cupolas with a somewhat smaller blower of the same type for the old cupolas.

The charging floor is at a height of 25 ft. above

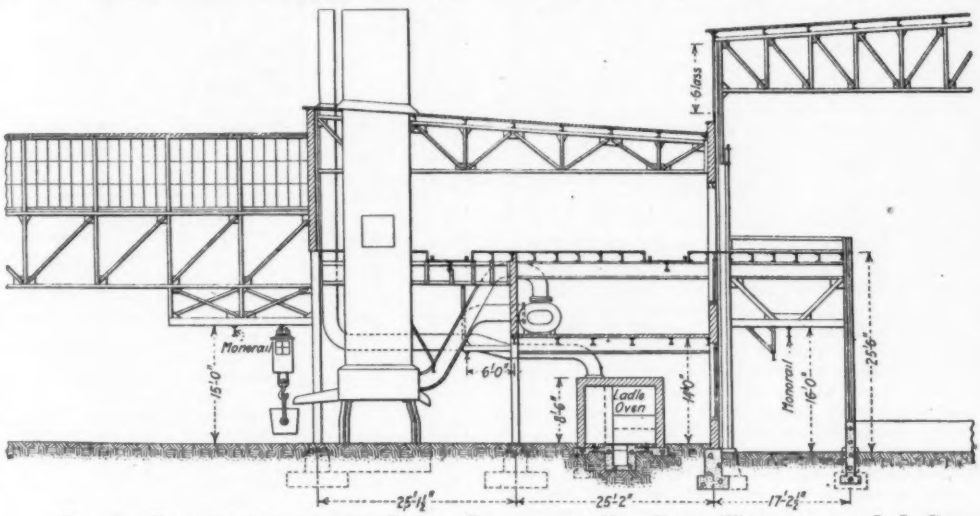

FIG. 1.—CROSS-SECTION THROUGH CUPOLA DEPARTMENT; NEW SOUTH WORKS OF THE J. I. CASE COMPANY.

the yard level, and is reached by two 8 by 8 ft. elevators of 7½ tons capacity, one at each end. These elevators are used only in emergency, the materials being handled ordinarily from the extension platform in small cars. Two parallel transfer tracks traverse the charging floor from one end to the other. Crossing the floor and intercepted by the transfer tracks are narrow-gauge tracks made of ⅞ by 2½-in. flat bars with a gauge of 2 ft., upon which the charging trucks move across from the extension platform to the cupola. On the one transfer track, the transfer car is equipped with scales for weighing, while the other transfer car gives added flexibility in mixing the materials for the row of cupolas. The cupolas are equipped with charging machines, so that the material is charged without handling direct from the cars. The accompanying drawing gives an idea of the overhead trolley system by means of which the ladles are carried around behind the cupolas to a ladle-drying oven.

On the same side of the foundry the remainder of the side bay will be used for the making of cores. The core ovens here installed are fired from the sub-floor space below, previously mentioned in connection with the sand bins. The fire pit is below. The core makers' benches are placed crosswise of the bay in front of the core ovens and along the line of the columns, the sand being brought to the benches by means of the monorail system. This entire floor is of concrete. For handling the cores from the benches and in and out of the ovens, steel trays have been provided of a design so that they can be nested while filled with cores. For the carrying of these trays the entire floor area is covered by small cranes. These cranes mounted on parallel runways, are hand operated from the floor and carry trolleys of 2 and 3 tons capacity.

The west bay on the opposite side of the foundry is a moulding floor throughout its entire length. This floor is similarly covered by means of parallel crane runways of 16 ft. span, dividing the floor area into moulding floors 16 ft. wide and 50 ft. long, extending from the column line to the wall. The moulding machines straddle the long pile of sand and move out toward the wall as the sand is made up into moulds, the moulds being laid down on either side following the machine until the floor is filled.

The central bay floor space is arranged for snap-flask work in two large floors. From the cupolas the hot metal is distributed in 4-ton ladles by way of the monorail. For pouring in the machine floors in the side bay, the iron is transferred from the monorail ladle to smaller bull ladles hung from the cranes overhead. For the snap-flask work in the centre bay the hot metal ladle is transferred from the monorail to the loop trolley and carried around to the point of the floor nearest to the moulds to be poured, where the metal is transferred to hand ladles.

The main foundry is separated from the cleaning room by a large locker and wash room enclosed between solid brick partitions, which leave only a passageway at either end for the monorail. Castings intended for tumbling and grinding are brought from the foundry on the monorail into the south side of the cleaning room. Here, overhead cranes of 3-ton capacity are installed in the same manner as in the foundry. By means of these cranes the castings are transferred into the tumblers and subsequently to the grinders and finally to the far side of the cleaning room, where they are picked up on another loop of the monorail for transportation over into the storage building. Castings to be sand-blasted are brought out of the foundry direct to the sand-blast rooms, through each of which a loop trolley is hung. The casting is then transferred from the monorail to the sand-blast trolley, which is so hung with relation to the sand-blast room as to permit the sand-blasting of the casting as it hangs from the trolley. After being cleaned the casting is then transferred back to the monorail and carried over into stock.

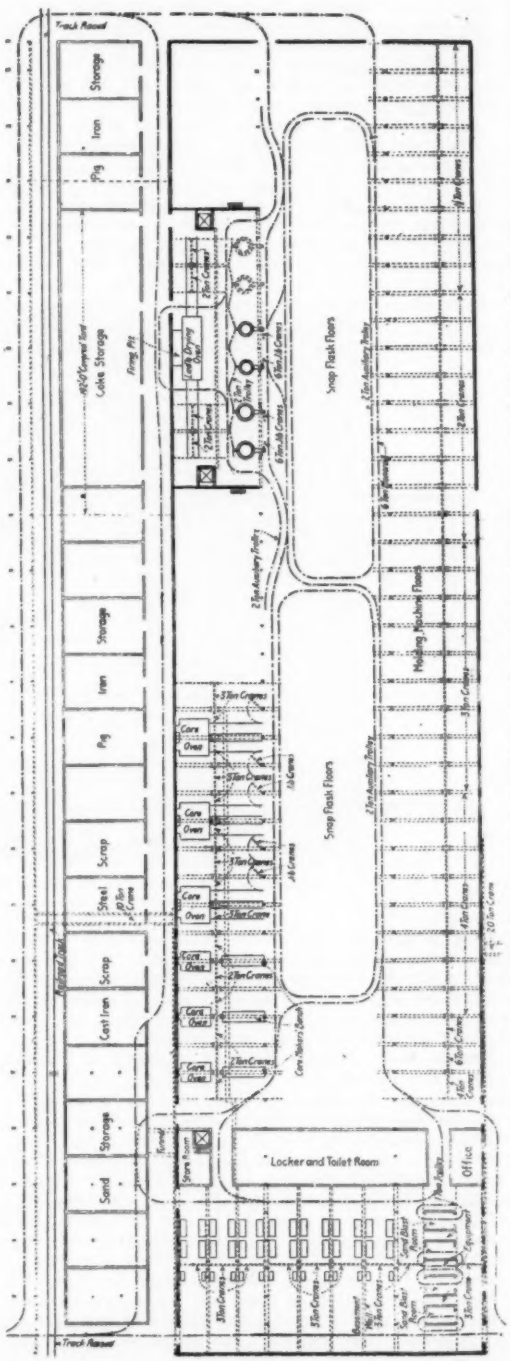

FIG. 2.—GENERAL PLAN OF FOUNDRY BUILDING; NEW SOUTH WORKS OF THE J. I. CASE COMPANY.

Special Irons.

By Sidney G. Smith.

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The term "special irons," though often used in the foundry, is rather vague, and may cover irons widely different in composition and character. It should imply a class, brand, or mixture of irons particularly suitable for certain kinds of castings or a class of work demanding an iron of a certain composition. But cold-blast, Swedish, and other of the various brands which may contain a high or low percentage of one or more of the metalloids, or manganese, are often termed special—for instance, an iron with a low total carbon content; an iron with extremely low silicon, phosphorus, and sulphur; an iron with high manganese and silicon, or one that is very low in all metalloids. Many of these irons are specially made for certain purposes.

Chilled and Grain Rolls.

Amongst the castings requiring what might be termed special iron are chilled and grain rolls. To produce a sound, uniform chilled roll the quality of iron is important, but there are other important factors, apart from the quality of the iron, that go to make a chilled roll with good wearing properties. It is not difficult to obtain an iron that will take a deep chill; the iron that will take the deepest chill is, as a rule, the most unsuitable. The chill is obtained by the rapid abstraction of heat from the surface that requires to be very hard, and to which the chiller is applied. The two important factors that determine the depth of chill are the thickness of the chiller (coupled with the method of chilling), and the quality of the iron. Cast-iron chillers are used for the purpose because they can be economically and conveniently made, while also iron is a good conductor of heat. The iron chillers themselves must be thick. It is obvious the thicker the iron chiller the more rapid and complete will be the abstraction of heat, and to this end water-cooled chillers, when practicable ought to be advantageous. It is considered that a ¾ in. deep chill in a roll with a suitable iron is satisfactory, but such is not always attained.

The iron for either chilled or grain rolls must have the maximum strength and toughness, and for this it should be low in total carbon silicon, and phosphorus (which latter content should only be consistent with fluidity). In the white chilled surface of the roll the carbon would be mainly in combination with the iron as carbide, changing towards the centre of the roll to cementite in a strong matrix of grey iron. Unless this quality of iron is approached the life and wear of the roll will not be satisfactory. An alloy such as ferro-manganese is sometimes used to induce chill, but in a roll care must be exercised in attaining this end not to produce brittleness and bad wearing qualities. A small percentage of ferro-vanadium in a roll iron can do no harm, and it is claimed that it prevents surface cracks and markings in the roll, which latter are due to repeated variations in contraction and expansion, resulting from the varying temperature of the roll.

Ingot Moulds.

Ingot moulds for steel, with which the writer has had considerable experience, form another class of work which demands a special iron. This must be hematite, which, although it generally contains high carbon is low in phosphorus, and should be fairly low in silicon. Its chief characteristic is toughness, and it is due to this property that the ingot moulds are less liable to crack under the effect of the repeated high temperature of the molten steel.

Hydraulic Pipes.

Hydraulic pipes, rams, cylinders, and connections form a class of work which demands a specially-selected iron, or mixture of irons. With this class of work the writer has had many years' experience. The iron must be dense and very close-grained, since these castings have to endure a pressure of from 2,000 to 3,000 lbs. in a 6-in. bore with 1½-in. section, and 400 lbs. pressure in a 40-in. bore with 2¼in. thick section, while being hammered at the same time. It must be quite obvious that in iron selected to stand this test without sweating the graphitic carbon contained must be in a very fine state of division, as otherwise sweating cannot be avoided, owing to the continuity of the iron matrix being broken up by the graphite flakes. The thickness of these castings also militates against a close iron by reason of the slow cooling; hence the iron selected (to speak in grade numbers) should be a mixture of equal parts of No. 4 and 5, or No. 4 with medium scrap, equal parts, of a brand of iron that is not excessively high in silicon or carbon. Such an iron will machine well, and give a smooth, close-grained, homogeneous finish. At the same time, the method of moulding these castings must not be overlooked. The best mixture of iron will give unsound and unsatisfactory castings if improper methods are employed, while a medium mixture of iron will give sound castings if proper methods are adopted.

Steam and Air Cylinders.

Steam and air cylinders, liners and connections, valves, motor cylinders, etc., also comprise a class of work that should receive special attention. An iron suitable for castings such as those mentioned should approximate to:—Total carbon, 3.25 per cent.; silicon, 1 per cent.; phosphorus, 1 per cent.; manganese, 1 per cent.; sulphur, 0.10 per cent. An iron of this composition, if well melted, will be very fluid, give splendid tests, and be close-grained, of clean fracture, and fairly hard, yet quite machineable, and when finished will give an extremely smooth surface. The best method of moulding, pouring, and feeding to produce soundness applies equally as much to the above castings as those previously mentioned, because liquid shrinkage, molecular action, liquid compression, and contraction are occurrences which are just as active in special irons as with ordinary irons; in fact, with some special irons such occurrences are more pronounced.

General Work.

With castings whose application and service demand no special qualities such as hard wear and resistance to shock, stresses, pressure, temperature, etc., the selection of the metal may be based upon silicon content and reliable grade numbers in relation to thickness—ordinary pig-irons, which may contain 4 per cent. total carbon, 3 per cent. of

FIG. 2.—GENERAL PLAN OF FOUNDRY BUILDING; NEW SOUTH WORKS OF THE J. I. CASE COMPANY.

silicon, and 1½ per cent. of phosphorus in the low numbers. The iron for the thinnest castings may be high in silicon, and, of course, the thick castings low in silicon, and between the very thin and thick a medium content of silicon. The variations in content of silicon in properly graded numbers, provided the blast furnace is working normally, should be uniform; but, unfortunately, from numerous causes, the normal working of the blast furnace is not always maintained, hence the irregularities between grade numbers and composition and the necessity of procuring iron by analysis.

To approximately estimate the composition of any brand of iron by numbers, a reliable, typical analysis of that brand must be available. There are very few brands of iron the typical or actual analyses of which are exactly alike, because of the different ore and ironstone used. Consequently, a graded No. 3, or any other number of one brand of iron will be widely different in composition from corresponding numbers in another brand of iron. Yet in all brands of iron the numbers correspond to fracture.

Silicon Control.

Much has been written and stated in regard to silicon control, the basis of which is the lowering of the percentage of silicon in the mixture as the castings increase in thickness. It is fairly common knowledge that for the castings the silicon content should be high to give the desired softness, and that to produce closeness and stiffness in thick castings the silicon should be low. For ordinary work the following basis of calculation is well worth consideration :—

	Silicon Per cent.
Castings under ¼ in. thick	2.55
„ averaging ¼ in. thick for Machine Parts	2.40
„ from 1½ to 2 ins. thick	2.25

Although all founders may not agree to the high percentage of silicon, yet it may serve as a foundation, or ground work, for a system of standardisation by analysis for general kinds of work. Ludw. Loewe & Company, Germany, have carried out a large number of tests for shrinkage, hardness, tensile and transverse strengths under ordinary working foundry conditions upon this basis.

Mr. G. Hailstone has suggested the following as the relation that should exist between thickness and composition of iron from which the casting is poured :—

Thickness of metal.	Silicon. Per cent.
¼ in.	2.70
½ in.	2.40
¾ in.	2.40
1 in.	2.00
1½ in.	1.75
2 in.	1.50
2½ in. to 3	1.25

The above should not always apply to steam cylinders, pipes, or valves.

Shots, Globules and Cavities in Castings.

In an investigation of these occurrences they must be clearly distinguished. A blow-hole must not be confused with a gas-hole, or with a liquid shrinkage or a draw hole. Also, it should be decided whether a honeycombed structure and sponginess are one and the same occurrence; and, if not, what is the difference, and the cause of each. From close observation and experiment the writer has come to the following conclusions :—

That possibly the formation of shots, or globules occurs in several ways. (1) As splashes, as during the pouring of a vertically-cast mould direct from the top, the liquid iron falling to the bottom, or coming into contact with some object, the splash drops so formed at once freezing. (2) By ebullition, as when pouring a casting from the bottom or side and the metal comes into contact with some hard or excessively moist, strong sand or substance and becoming irritated throws up shots. In both cases the shot would rise from the surface of the iron and return to the surface, where most of the impurities are likely to be, and the shot in rising would rapidly solidify, which would to some extent account for its hardness; it actually passes through an oxidising, bluing process in the mould, this giving it a peculiar smooth blue skin or film. This film appears to require a high temperature to penetrate, dissolve, or melt it, and hence the shots become embedded sometimes in large numbers in the upper part of the casting, or are trapped underneath any projections, such as

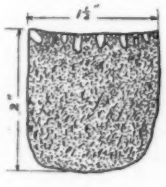


Fig. 1.

Fig. 5.

flanges, branches, brackets, etc., which may be situated at the bottom, middle, or top of the mould the skin or film protecting them from being remelted.

The formation of gas cavities, apart from air, blow, sinkage or draw holes, is probably due to entangled or trapped gases, mechanically in solution, combined or mixed with the molten iron. These gases endeavour, under the pressure of cooling metal, to escape, but are interlocked and prevented from doing so by the outside walls being frozen, while the weight above is too great for the gas to penetrate. The writer is of the opinion that such gas cavities, excepting very small ones, are very rare indeed, and what are supposed to be gas cavities can be attributed to other causes.

Reference has so far been made to the formation of shot alone and cavities alone. But there are also cavities containing loose shots and shots attached to or partly developed in the cavities. Such cavities sometimes appear as large as a chestnut, with the globule partly developed from the bottom of the cavity.

Very small cavities are formed by the shots, and they are found with the iron solidified closely around them, and such are sometimes found in any part of a casting. To the writer it seems fairly clear that small shot and hard spots encountered in the machine shop are originally from the causes mentioned, namely, splashes and ebullition, the shots locating themselves just where the machine tool will find them, unless provision has been made to get rid of them. Sulphur has not been mentioned because the writer does not associate it with the phenomena under consideration.

The difference between honeycomb and sponginess may be defined as follows:—Honeycomb is an accumulation of scum, dust, shot, small cavities formed by the shot, and small gas-holes confined in a skin of iron floated to the top, or trapped in some part of the mould. Sponginess is that part of a casting, wherever situated, that has been feeding some part and has not itself been fed, and is, consequent

on the iron being drained or drawn away from that part, extremely porous and unsound.

The composition of the iron is not of great importance in reference to hard shots and gas cavities, as cavities occur and are often seen in all grades of pig-iron, although with the idea of minimising the trouble when it occurs a softer grade may be used when practicable. With a rather hard or close-grained iron, say, between a No. 4 and 5, the occurrence is more liable on account of the fact that a

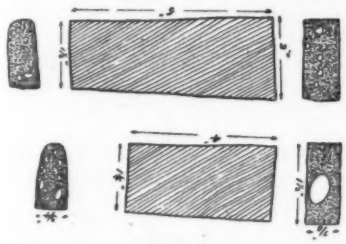


FIG. 2.

hard, dense iron is more easily irritated than a soft, open-grained iron. This peculiarity may be observed almost any time when such irons are used, by the fall from the cupola spout into a large ladle, or when running open-sand castings. A soft, lead-like iron will rest quietly in a mould where a harder iron will scab.

Any grade of iron may produce shots and cavities; it is a question of comparative liability. Also, their formation is equally possible in dry and green sand, or skin-dried and loam moulds.

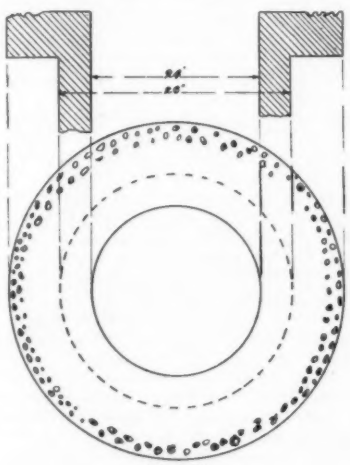


FIG. 3.

Examples of Defects.

The sketches herewith show some examples of the foregoing defects which have come under the writer's notice :—

Fig. 1 is a piece of open-sand runner gate, showing gas holes at the top, with a skin covering the iron.

Fig. 2 depicts two pieces of broken prods of a core iron, showing air holes, not gas holes. The distinction is that absorbed gases are supposed to evolve from the iron during cooling, and air or blow holes result from ordinary air trapped.

Fig. 3 is a piece from the top flange of a casting 9 ft. long, vertically moulded and poured, showing accumulation of shots, cavities, and probably both gas and air holes trapped in the flange. This is a rare occurrence with large feeding heads.

Fig. 4 shows pieces of flash or fin from the top of the feeding head of a 60-in. external flange cylinder

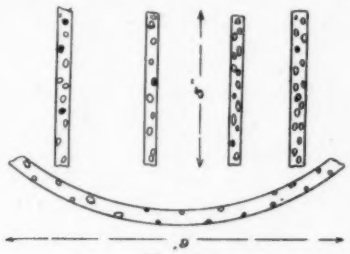


FIG. 4.

made in loam, a number of air holes being depicted.

Fig. 5 depicts globules and shots taken from feeding heads and other parts of castings at different times. Each has a blue film or skin, and they are of varying degrees of hardness. Part of one small one looked at through a magnifying glass shows the formation of another cavity, and probably a shot has occupied it (see enlarged sketch).

ANNEALING STEEL CASTINGS.—The following recommendations as to the annealing of steel castings were adopted at the recent Atlantic City meeting of the American Society for Testing Materials:— (1) The castings should preferably be sufficiently cleaned of adhering sand before annealing to ensure thorough and uniform heating (2) The castings should be heated slowly and uniformly to temperatures varying with the carbon content of the steel, approximately as follows :—

Carbon, per cent.	Temperature, deg., cent.
Up to 0.16	925
0.16 to 0.34	875
0.35 to 0.54	850
0.55 to 0.79	830

Nothing in these recommendations shall operate against the temperatures aimed at being 50 and, in special cases, 100 deg. C. higher than those given in the table, when necessary to attain the desired result. (3) The castings should be kept at the maximum temperature a sufficient length of time to ensure the refining of the grain. In general, the heavier the sections of the casting, the longer must be the time of exposure to the maximum temperature. (4) (a) The castings should be cooled slowly and uniformly in the furnace, when it is desired that the steel shall possess the maximum softness. (b) The castings may be cooled at an accelerated rate, when it is desired that the steel possess rather higher tensile strength and elastic limit than can be procured by very slow cooling. This cooling must be so conducted as to leave the steel reasonably free from cooling stresses. The manner of carrying out this accelerated cooling should be such as will attain the desired result. For instance, the castings may be withdrawn from the furnace and buried in a bed of material that is a poor conductor of heat; or the annealing furnace may be so thrown open that it will cool more rapidly than if left closed. Should the castings be of such uneven section that they cool at unequal rates at various points when the furnace is opened, especially if the carbon of the steel is high, the furnace should be closed after the castings have become black, and their further cooling so retarded that the stresses set up by the unequal rates of cooling are relieved.

Tropenas Converters v. Electric Furnaces for the Manufacture of Steel Castings.*

By G. Muntz.†

The fact is often overlooked that although steel as found in channels, I-beams, rails, etc., has almost the same characteristics as the steel that goes to make steel castings, the peculiar conditions inherent to the two manufactures are absolutely different. It is well known what the Tropenas converter can do and it is only necessary to state the claims of the electric furnace used to-day to manufacture steel castings :—

(1) The metal obtained is lower in phosphorus and sulphur contents than converter steel.

(2) Segregation in electric steel is less than in converter steel.

(3) Starting with cold steel scrap electric steel is cheaper to produce than converter steel.

(4) Absolute uniformity.

The writer will not take these claims and criticise them one after the other, but will simply draw a parallel between the Tropenas and the electric process and point out the obvious conclusions.

Reliability of the Tropenas Process.

It is well to define here what is called the Tropenas process. Side blowing is an old idea, and even Bessemer, in his converter at St. Pancras, was blowing through the metal on the side and near the bottom. Adamson, Clapp, Griffith, Witherow, Walrand, Robert, all blew on the side of their converters, but each farther from the bottom. Tropenas was, the writer believes, the first to blow on the surface of the metal, or better, between the slag and the metal. This principle, we think, characterises the Tropenas process. This point being clear, the extreme reliability of the Tropenas converter, even when operated by a seemingly inexperienced steel man, may be emphasised. We all know that the Bessemer process and its derivatives alike are first of all ideal means of decarburising pig-iron. A converter cannot be better compared than to an oil lamp. As long as the oil is plentiful, the lamp is burning brightly; when the oil gets low the flame begins to flicker, and when the oil is almost gone the flame drops. In the converter we burn mainly carbon; a flame ensues, which will flicker when the fuel is almost gone and will drop when carbon exists only as traces in the final bath. With a converter the signs indicating the end of the operation are absolutely unmistakable and the blowing itself is so simple that operators can be trained to be most reliable in a very short time. Steel making by the converter process depends mainly on good cupola practice whereby suitable metal is secured for refining in the converter. This feature is a decided advantage and must be taken into careful consideration when comparing the Tropenas process to any other.

The electric process, like the open-hearth and other similar methods, entails the use of closed furnaces, in which no outward signs are in evidence when the steel has reached the suitable composition. Test bars must be secured at various intervals and the quality of the steel determined in various ways or by direct examination of the fracture. It is easy to see that the personal equation plays here an important part, and that very experienced men must be secured to properly melt and refine in an electric furnace.

The Electric Furnace as a Melting Apparatus.

Expert melters are scarce and command good salaries. Inasmuch as the electric furnace cannot compete with the basic open-hearth process, as far as cost of production is concerned, and is therefore limited to the small capacities, the resulting business ventures are comparatively small and do not admit of paying the large salaries which the big steel companies can allow to their experts. This is why the electric furnace has adopted the method followed by the old crucible process, whereby the furnace is used as a melting apparatus pure and simple.

The electric furnace has over the converter the great advantage that it can use such material as boiler punchings, turnings, borings, etc., which could not be melted in a cupola; so that although it is not as efficient a melting furnace as the cupola it can use cheaper raw material and thereby offset the loss in efficiency to its advantage. Statistics show, however, that although steel scrap is to-day at the same level as it was ten years ago, it has fluctuated very widely and often reached such levels as would have rendered the electric furnace a prohibitive melting method.

When determining the cost of liquid metal we find that the factors to be considered are well defined in the converter process, while in the electric furnace the main item, mainly, the electric power, is a very uncertain quantity. We will disregard the actual amount of current needed to melt 1 ton of steel, as opinions and experiences differ on that score, but there must be considered the cost per unit of the current itself. Steel foundries have given up the idea of manufacturing their own power. The investment required is too great compared to the returns to be expected, and the service offered by the electric companies is so superior that in most cases it is adopted. This advantage is offset by the fact that current is sold according to a sliding scale whereby rates decrease as consumption increases. It is found that in most cases the operation of an electric furnace is prohibitive when the number of operations does not allow the purchase of current at the favourable rates of the scale. In other words, while a converter can be operated only once without great increase in cost of production, the same cannot be done with the electric furnace except at great loss.

Uniformity of Product.

It is a well-known fact that when melting in an electric furnace the phosphorus and sulphur contents will not increase, but so far as steel castings are concerned these two elements are not of such capital importance. This, however, cannot be said of the carbon content of electric steel, which is not controlled as easily as in the Tropenas converter. In the converter, with operations stopped always at the proper time, absolute uniformity is realised and steels

* "Metallurgical and Chemical Engineering."

† Tropenas Converter Company, New York.

of any carbon content can be obtained at will by the use of suitable additions. Table I. of fifty consecutive blows in two Tropenas "baby" converters shows what can be expected from the latter process.

In the electric furnace, final additions of ferro-manganese and ferro-silicon are made either to obviate oxidation of the metal or to carburise the steel to such an extent as will render it better suitable for the purpose intended, or both. The final product will then contain more carbon than the raw material first used, and inasmuch as at least 35 per cent. of the steel poured is returned to the furnace in the shape of gates and risers, the carbon content will keep on increasing, if delicate refining is not resorted to. The obvious conclusions is that the electric furnace as a melter will entail variations in carbon, which will occasion very noticeable changes in the physical properties of the steel produced.

TABLE I.—*Tests from two Tropenas Baby Converters Blowing Alternately.*

Si.	Phos.	S.	C.	Si.	Phos.	S.	C.
0.26	0.050	0.048	0.220	0.23	0.048	0.040	0.208
0.27	0.055	0.047	0.225	0.23	0.046	0.049	0.244
0.26	0.045	0.046	0.208	0.23	0.048	0.048	0.220
0.28	0.048	0.050	0.215	0.25	0.048	0.049	0.215
0.29	0.050	0.048	0.220	0.23	0.050	0.047	0.228
0.26	0.056	0.054	0.214	0.24	0.046	0.047	0.217
0.30	0.048	0.046	0.218	0.31	0.045	0.050	0.220
0.26	0.050	0.046	0.218	0.32	0.050	0.054	0.212
0.27	0.056	0.048	0.224	0.28	0.050	0.050	0.206
0.28	0.060	0.053	0.240	0.32	0.046	0.048	0.210
0.30	0.054	0.048	0.228	0.33	0.048	0.049	0.212
0.28	0.050	0.046	0.214	0.31	0.046	0.047	0.210
0.28	0.060	0.056	0.200	0.31	0.047	0.047	0.210
0.27	0.050	0.051	0.228	0.27	0.050	0.054	0.227
0.31	0.056	0.050	0.215	0.27	0.055	0.049	0.190
0.28	0.055	0.047	0.200	0.27	0.055	0.049	0.190
0.27	0.050	0.046	0.204	0.23	0.048	0.045	0.218
0.26	0.098	0.044	0.202	0.26	0.040	0.045	0.218
0.28	0.050	0.044	0.210	0.25	0.043	0.049	0.198
0.27	0.055	0.050	0.224	0.25	0.043	0.049	0.190
0.27	0.058	0.052	0.216	0.26	0.043	0.045	0.215
0.30	0.050	0.048	0.220	0.27	0.044	0.044	0.230
0.31	0.050	0.044	0.215	0.30	0.044	0.043	0.238
0.30	0.056	0.049	0.214	0.28	0.045	0.046	0.206
0.31	0.048	0.045	0.198	0.28	0.045	0.046	0.206
0.30	0.050	0.045	0.217	0.32	0.045	0.045	0.205
0.32	0.050	0.047	0.200	0.30	0.045	0.050	0.238
0.25	0.054	0.045	0.228	0.27	0.044	0.046	0.238
0.25	0.054	0.048	0.198	0.25	0.042	0.045	0.217
0.20	0.051	0.045	0.210	0.26	0.042	0.045	0.230
0.27	0.053	0.049	0.196	0.23	0.042	0.045	0.232
0.29	0.050	0.044	0.214	0.30	0.042	0.053	0.237
0.30	0.060	0.053	0.202	0.31	0.046	0.049	0.212
0.31	0.058	0.050	0.196	0.30	0.046	0.049	0.212
0.25	0.064	0.051	0.190	0.31	0.046	0.049	0.225
0.28	0.055	0.052	0.195	0.29	0.045	0.050	0.208
0.27	0.051	0.049	0.194	0.28	0.045	0.050	0.223
0.30	0.050	0.045	0.226	0.27	0.050	0.055	0.206
0.33	0.050	0.048	0.216	0.26	0.054	0.046	0.220
0.30	0.048	0.044	0.200	0.26	0.053	0.053	0.238
0.27	0.046	0.042	0.224	0.28	0.052	0.054	0.202
0.26	0.048	0.042	0.192	0.26	0.056	0.049	0.226

Average manganese 0.80 to 0.90%. Variations in analysis are due to different weights of metal blown without altering weights of final additions. Average weight of blow, about one ton; average time of blow, 12 minutes.

Tests made by Michigan Steel Casting Company of Detroit, Michigan.

Capacities of Furnaces.

Most of the steel foundries to-day are jobbing foundries and are called upon to produce a great variety of castings, some of which are bulky but made of thin sections, others bulky and heavy, others again small and weighing only a few ounces. To meet the peculiar exigencies of the steel-casting business a furnace must, therefore, be flexible and able to produce metal of such temperature and in such quantities as will be suitable for any class of castings. Proper temperature can be obtained in both the electric furnace and the Tropenas converter and either process can produce castings which could not be poured successfully otherwise. Very hot metal can be had at no additional cost in the converter, and at slight additional cost in the electric furnace. The whole problem reduces itself to one of furnace capacity.

The electric furnace has the advantage over the converter that it allows control of the temperature of the metal. This feature is valuable when metal has to be kept in the furnace for some reason or other; once the correct temperature is reached, it can be maintained at slight additional expense. Metal can be held in the converter but not indefinitely as in the electric furnace. This brings out the fact that the electric furnace is limited in capacity to its own charge. In other words, a 2-ton electric furnace will produce 2 tons of steel every two and a-half or three hours. If we compare this to what can be done in a converter of equal charge capacity we find that from two to three operations can be made per hour, thereby allowing the accumulation of from 4 to 6 tons of steel per hour. In one instance of an 18,000-lb. casting being poured successfully with a single 2-ton converter. Six blows were made to secure sufficient metal, each blow being poured on top of the other in a ladle; it took 1 hour 45 minutes to make the steel and after the casting was poured there was not even a skull left in the ladle. This shows that even after waiting almost two hours the steel was still very hot.

This feature of rapidity of operation is one of the great factors in favour of the converter. It reduces itself to the fact that even should an electric furnace be as cheap of installation as a converter of equal charge capacity (which is not the case). it would take five or six 2-ton electric furnaces to produce the work of one 2-ton converter.

Segregation.

The various impurities which are found in steel have different freezing points, and show a tendency to segregate and concentrate in certain portions of large bodies of cooling metal. This segregation is affected by various factors such as initial temperature of the molten mass and especially the rate of cooling. From experiments made by Talbot in 1905 it was concluded that sulphur segregates most, phosphorus next, then carbon, and finally manganese. It was found also that the usual additions of aluminium reduced the segregation considerably.

Authorities differ as to the elements which segregate first, and Professor Howe shows that carbon segregates the most readily. It is therefore interesting to apply either results to the particular case on hand.

The field covered to-day by the Tropenas converter and the electric furnace is such that metal manufactured by either process freezes almost instantly after being poured. Small and medium steel castings offer numerous surfaces of cooling and even if the steel produced by the converter process contains more sulphur and phosphorus than electric steel, segregation will take place only in negligible quantities, as the rate of cooling is too great to allow any extensive concentration.

On the other hand, if we adopt the conclusions of Professor Howe, segregation will be greater in electric steel, inasmuch as carbon tends to be higher than in converter steel.

Influence of High Sulphur Content.

It is a well-known fact that with sulphur up to 0.1 per cent. the direct action on ductility and tensile strength is negligible. The only detrimental effect of sulphur is to cause red shortness, or cracking and checking if the steel has to be forged or rolled.

Neither the converter nor the electric furnace contemplate, to any great extent, the manufacture of steel castings which will later be forged. It follows that a higher sulphur content in converter steel would not prove detrimental to steel castings, especially if the manganese content were properly graduated to offset any possible bad effect due to sulphur. The only advantage of very slow sulphur therefore seems to apply to the rare case of steel castings which have to withstand high temperatures.

Influence of High Phosphorus Content.

Phosphorus is the element which is the most detrimental to steel, as it creates brittleness under shock, and general cold-shortness. It is the consensus of opinion that phosphorus contents should not exceed 0.08 per cent. for all practical purposes. Between 0.05 per cent. and 0.1 per cent. the elongation and reduction of area are not affected to any great extent, while the tensile strength increases. The readings of the testing machine are not therefore of any special value when the effects of phosphorus are considered. Cold bending tests, by use of a drop, are best suited to determine the quality of steel castings, but in the case of phosphorus we find results erratic and capricious and it seems that on this score the best factor to be considered after chemical analysis is the reliability of the producers of the steel.

In the present controversy it must be admitted that the electric furnace has the advantage of being able to use such raw materials as will ensure low phosphorus, but accumulation of phosphorus is very slow in the converter process and the chances of picking it up from fuel while melting are very remote. It is, therefore, just to say that converter steel while higher in phosphorus than electric steel, more than comes within the ordinary limits of safety.

Hints on the Cupola for Beginners.

When starting the cupola fire some dry shavings or oiled waste should first of all be put into the bottom of the cupola, then some small pieces of wood, and then heavier wood, using just enough wood to set the coke burning rapidly. Many cupola attendants used far too much wood, which not only means a waste of wood, but fills the bottom of the cupola with ashes, and so prevents the fuel from settling down to give the proper support necessary to the iron when charged. After the wood is well alight sufficient fuel should be placed on so as to get a good start with the fire, and when this is well alight more fuel should be added. After this has got a good hold the remainder of the fuel is then put on, and should now reach between 18 to 24 in. above the top of the tuyeres; as soon as this burns up evenly the cupola is ready for charging the iron. Great care should be taken before charging the iron to see that the fuel is thoroughly alight all around the sides of the cupola, as otherwise it is apt to cause dull iron and a subsequent loss of castings.

The fire takes from two or three hours to burn up in good condition ready for charging the iron. Some cupola attendants put on a light blast about one hour after starting the fire, but this method is not to be recommended, and should be avoided as far as possible, although when it is necessary to have a hurried blow this method has to be adopted.

The question that baffles many beginners is what weight of iron should be in the charges for the various sizes of cupolas. This varies, as no two cupolas work exactly alike; but as a rough-and-ready guide the weight of iron to charge is 2½ cwts. of iron for a cupola 20 in. internal diameter, and for every increase of 4 in. in the internal diameter another 2½ cwts. should be added. Although these figures can be increased, it is advisable for the beginner to start with this quantity, gradually increasing his charges till he gets the exact amount the cupola will melt with ease. One great advantage of small charges of iron, providing there is a sufficient quantity of fuel between the charges, is that iron melts to the best advantage when the whole of the coke is burning equally throughout, so that the smaller the charge of iron employed the smaller is the quantity of fuel required, and it is quickly consumed, whereby the melting of the iron is much quicker.

The next point for the beginner is how much fuel should be placed between the charges of iron. As a rough guide the proportion is 1 part of fuel to about 8 parts of iron, but with experience this can be varied to suit the cupola. It is always the safest plan to use sufficient fuel, because if the fuel is cut down too much it will only result in dull iron; on the other hand, it is no good going to the other extreme by using too large a proportion of fuel, as this is not only a waste of fuel but prolongs the melting also. In one case known to the writer twice as much coke was used as was necessary, and this greatly decreased the speed of melting. The cupola only melted about 15 cwts. per hour in full blast, but when the coke was reduced to the proper quantity the speed of melting was increased to 25 cwts. per hour.

Great care must be taken when charging the cupola to see that the proper proportions of iron and fuel are charged, because if too little fuel is used between the charges the bed as it is consumed will gradually lower itself to the level of the tuyeres, with the result that the metal will be very thick, and might result in a complete stoppage of the cupola. On the other hand, when too much fuel is placed between the charges the bed is raised above its proper level, and the iron melts very slowly, or melting may be entirely stopped till the bed has burned down to its proper level. One advantage of a high bed over a low one is that the iron will be much hotter when tapped from the cupola. In charging a cupola the largest pieces of iron should be charged on the fuel, with the smaller pieces on top. This rule holds good whether pig-iron or scrap is being charged, and by carefully following this rule more uniform melting will be secured and the resulting mixture will be of a more uniform quality.

Many founders pay but very little attention to the amount of flux charged in the cupola, but this is an item which requires careful consideration, as not only does it clear away the sand, dirt and rust charged with the iron, but it has a great influence on the sulphur, and in many cases the sulphur content has been found to be greatly lowered by using a larger amount of flux. Many founders do not use any flux with the first few charges, but it is just as important that the first charges should receive consideration in that respect as the succeeding ones. A case was known to the writer where a large majority of castings made from the first metal down came out very hard and sometimes were unable to be machined, but when flux was used with the first and succeeding charges, other conditions being exactly the same, the trouble was entirely done away with. The amount of flux used depends entirely on the iron used; when the iron is of a very dirty nature it requires a larger amount of flux than does good clean iron. With dirty iron about 65 lbs. of flux per ton of iron should be used, and this can be reduced to about 35 lbs. with good clean iron.

When the slag is running fluid, it is an indication that a proper amount of flux is being used, although sometimes the proper amount of flux is charged, but the cupola may be running cold, and this will cause the slag to turn dull. But whatever the cause, close attention should be given to the slag, because if allowed to chill at the tuyeres through being sluggish, it may cause a great amount of trouble, as not only will it stop the meltings but it may bridge the furnace, so that it is nearly impossible to clean the cupola out after the blow.

Micro-Actions of Acids and Metals.

By James Scott.

The effects of the acids with various metals constitute an important matter. Gold, as is well-known, is not affected by any single acid, but will yield to an attack of *aqua regia* (nitric acid combined with hydrochloric acid), and this fact provides a convenient test for the precious metal. Brass, on the other hand, yields a blue or green salt when touched with nitric acid (*aqua fortis*).

The microscopical effects of various familiar acids on the five metals selected will be shown, commencing with nitric acid or *aqua fortis*. It will be inadvisable to deal with results which do not lend themselves to illustration, so the writer's remarks will be confined solely to experiments that produce picturesque salts. It will be noticed that in some cases the crystallisation does not conform to one's expectations after reading text-book information copied from previous volumes. One may obtain large, definitely-shaped crystals by evaporating solutions of the respective salts; but it does not follow that the microscopical forms will always be exactly similar. It is by describing precisely what does occur when an acid dissolves a metal that work is made instructive.

It should be understood that when a salt is obtained, and that is re-dissolved and again evaporated, the crystalline appearance may be quite dissimilar from the original one.

For the writer's experiments, in which pure metals were used, a few drops of concentrated nitric acid were placed on glass slides, and then small portions of the respective metals introduced into it until they were nearly or wholly dissolved. According, as was believed to be most suitable, the acid was left of the normal strength, or else diluted to half its volume with water. Some examples were left to operate in the cold state, while others were heated over a lamp chimney. These points will be made clear later. In all cases the discs depict magnified pinholes of about $\frac{1}{24}$ in. diameter. This will enable readers to form some idea of the extent of magnification adopted. The brilliant white effect is produced by turning off the reflecting mirror of the compound microscope, which adjunct, by causing light to pass upwards, gives a clear disc with darkened objects thereon, and thereby relying only on the light transmitted from one's lamp. In such cases a dense black background is obtained, and by focussing the light on to the slides the details of the salts are shown very sharply.

The first noticeable feature of the dissolving process is that hosts of minute bubbles of gas are ejected from the metals; the latter in some instances rushing about violently owing to the energy aroused, the bubbles meantime springing out in extremely rapid succession, and bursting at once. Sometimes the action is a fairly slow one.

A scrap of sheet silver was placed in the acid, and the mixture left until the following day, when it was examined and found to have been resolved into a layer of white salt (silver nitrate) consisting of fine needles arranged either loosely or in branching tufts. Scattered at intervals were some semi-opaque white crystals showing a minutely scored surface. Round these the thinner film was "fuzzy" or speckled in aspect, and full of oval spaces. Fig. 1 depicts these features. The lunar caustic used by surgeons is silver nitrate melted and poured into stick-shaped moulds.

Fig. 1.—Nitrate of Silver; Dense White Crystals and Fine Needles, Produced with Cold Nitric Acid and Silver.

Fig. 2.—Nitrate of Silver; Produced with Nitric Acid and Silver, Heated.

When a mixture of concentrated nitric acid and silver was heated, the salt was arranged in the form of pretty feathery tufts of the kind depicted in Fig. 2. Among the denser portions were upheaved masses of parallel bars or prisms. The salt in that condition was very dilequescent, as it soon attracted moisture from the air, and commenced to re-dissolve.

Into a dilute solution of nitric acid was put a piece of copper foil. It was almost amusing to note the rapid manner in which the metal vanished and was replaced by a blue solution of copper nitrate. Most readers will know that copper sulphate is

similarly blue, and is called bluestone, a term which is not habitually applied to copper nitrate.

When the metal was dissolved the solution was heated, and it was found that it dispersed into different kinds of layers, the chief of which consisted of a comparatively stout mesh caused by the concentration and subsidence of the blue liquor between

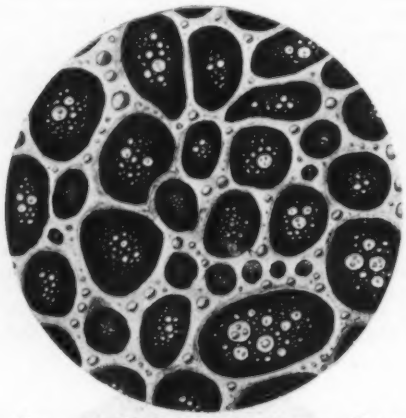


FIG. 3.—NITRATE OF COPPER; BLUE NETWORK PRODUCED WITH DILUTE NITRIC ACID AND COPPER.

numerous bubbles which burst and left the network now being considered. Tiny bubbles of coppery and vari-tinted appearance existed at the bases of the openings, or vanished bubble spaces, and were also arranged outside this area round small clear circular spots. In Fig. 3 these details may be seen. This blue mesh was very dilequescent, and as the

FIG. 5.—NITRATE OF LEAD; CRYSTALS PRODUCED WITH COLD NITRIC ACID AND LEAD.

moisture re-entered the modified metal, bubbles arose and travelled along the channels in a very interesting way. When the cold acid was used to dissolve the copper the result was the appearance of a greasy-looking film, which puckered up into various patterns, some roughly star-like. With the hot dilute acid similar phases subsided to a flaky condition as the creases fell out flat. At the same time, irregular stripes or fine lines occurred at various parts. Copper nitrate must be dealt with in larger amounts if crystallisation is needed.

Concentrated nitric acid and zinc dust heated gave the opportunity for depicting the very remarkable appearance shown in Fig. 4. Dense smoke-like

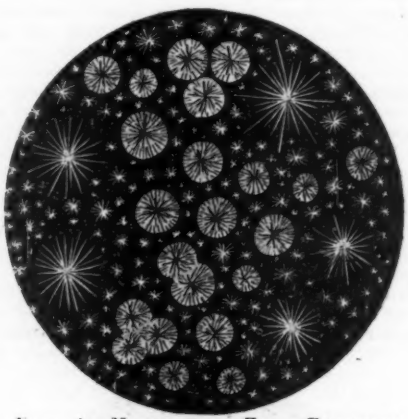


FIG. 4.—NITRATE OF ZINC; PRODUCED WITH NITRIC ACID AND ZINC, HEATED.

fumes, out of all proportion to the small amount of zinc dissolved, arose the moment it touched the acid, and there remained in consequence of the action a white damp-looking salt, which was found to consist of fairly large stellate groups of minute needles, and discs or spheres with radiating centres. Scattered between these were very minute clusters of

FIG. 6.—NITRATE OF LEAD; PRODUCED WITH DILUTE NITRIC ACID AND LEAD, HEATED.

points; the whole mass producing an attractive spectacle. In the cold solution of nitric acid, the zinc was modified into crude rosettes which, because of their opacity, were not considered worth sketching, they being more like tiny balls showing teeth-like projections on their contours.

Concentrated nitric acid and lead foil caused some

peculiar little crystals to emerge from the cold solution, as in Fig. 5. These may be thin plates, or comparatively bulky, solid objects; but at all times they are as transparent as glass, an aspect which would be hardly expected by observing the nitrate in mass. The crystals float about in the excess acid, which does not readily evaporate. Lead nitrate is one of the mediums for the production of the much-discussed peroxide of nitrogen, obtainable when the nitrate is heated. The geometrical crystals can be pushed about by means of a hair or bristle, and grouped together, as shown.

Lead, when dissolved in heated dilute nitric acid behaves as shown in Fig. 6, the salt spreading out as a delicate tracery of straight shafts, which assume all angles of position in relation to one another.

Tin is turned to a white hydrate of binoxide in nitric acid. This possesses the curious property of refusing to dissolve in acids. Many other strange facts concerning tin could be given; but at the moment the writer is dealing only with the subjects illustrated.

The reasons why metals are coloured in various ways, the hues altering according to treatment, is a subject which can only be fully understood by making microscopical experiments. In many of the tests depicted, some of the films accompanying the salts were rainbow tinted.

The Uses of Manganese Ores.

In a section of "Mineral Resources of the United States," issued by the U.S. Geological Survey, Mr. D. F. Hewett remarks that for commercial purposes materials containing manganese are separated into four classes:—(1) Manganese ores, (2) manganiferous iron ores, (3) manganiferous silver ores, and (4) manganiferous zinc residuum. This classification is based on the character of the materials now available in the United States and is due largely to the nature of the deposits, and as it is purely commercial it may be incomplete if applied to resources in foreign countries, or it may contain superfluous classes. Practically all the manganese of commerce is derived from material containing one or more of the first seven of the minerals named in the following table:—

Principal Manganese Minerals.

Mineral.	Composition.	Percentage of manganese.
Polianite	MnO_2	63.2
Pyrolusite	$MnO_2.nH_2O$	60–63
Psilomelane	$MnO_2.(MnKBa)O.nH_2O$	45–60
Wad	Hydrous impure mixture of manganese oxides	5–50
Manganite	$Mn_2O_3.H_2O$	62.4
Braunite	$3Mn_2O_3.MnO.SiO_2$	60
Franklinite	$(FeZnMn)O.(FeMn)_2O_3$	10–19
Rhodochrosite	$MnO.CO_2$	47.56
Rhodonite (manganese pyroxene)	$MnO.SiO_2$	41.9
Tephroite (manganese olivine)	$2MnO.SiO_2$	54.3
Spessartite (manganese garnet)	$3MnO.Al_2O_3.3SiO_2$	33.3

Commercial manganese ores are those which contain at least 35 per cent. manganese and otherwise conform to the specifications of the trade in which they are used. Manganiferous iron ores consist of mixtures of manganese and iron oxides and hydrous oxides, which though usually containing manganese in excess of 5 per cent., may contain as little as 1 per cent. The proportion of iron in such ores is highly variable, but usually exceeds 40 per cent. Other manganiferous iron ores, which are so low in manganese that they are classed as iron ores, yield in the blast furnace a "high-manganese" pig-iron, which is used for special purposes. Manganiferous silver ores consist of mixtures of manganese and iron oxides and hydrous oxides, with small quantities of silver and lead minerals. As a rule the iron content exceeds the manganese content. The greater part of the manganiferous silver ores mined are used for their silver and lead content, but some such ore is too low in silver and lead to be used as a source of these metals, though sufficiently high in manganese and iron to be used for the manufacture of ferro-manganese and spiegeleisen, a use that is made also of the high-grade manganiferous iron ores already mentioned.

Manganiferous zinc residuum is not sold in the open market but is smelted to spiegeleisen by the companies that produce it.

Among the chief uses of manganese rank the alloys:—Ferro-manganese and spiegeleisen (alloys of manganese and iron); manganese steel; silicospiegel (alloy of manganese, iron, and silicon); manganese bronze (alloy of manganese and copper); silver bronze (alloy of manganese, aluminium, zinc, and copper); and alloys of manganese with aluminium, zinc, and tin.

Three classes of ores—manganese ores, manganiferous iron ores, and manganiferous zinc residuum—are used directly or indirectly in the manufacture of iron and steel. Ore used in the manufacture of iron-manganese alloys should contain at least 40 per cent. manganese and less than 0.20 per cent. phosphorus. Silica and other impurities are easily eliminated in the operation of smelting, but most of the phosphorus in the ores remains and is present in the final product. For making non-ferrous manganese alloys, high-grade ores relatively low in iron are desired. Manganiferous iron ores are not now used in the manufacture of iron alloys of manganese, such as are used in the steel industry, but are used for the direct production of manganiferous pig-iron, which is used for making various kinds of castings, such as car wheels. It possesses considerable resistance to abrasion.

Though manganese in the form of ferro-manganese is added to practically all steel, whether produced by the Bessemer or the open-hearth process, the quantity present in the final product is not so large as greatly to affect its physical properties, at least not to the same extent as the carbon content. Manganese steel contains from 12 to 40 per cent. manganese, and these proportions are essential to produce the peculiar properties possessed by these steels, which are hard, but, with proper heat treatment, not brittle, and malleable, though they offer great resistance to cutting tools. These properties make the manganese steels highly useful in the manufacture of two classes of articles:—(1) Those which must offer great resistance to abrasion, either by friction against smooth, hard surfaces, or against hard, brittle, and angular materials; (2) those which must resist strains due to shock accompanying such abrasion. Articles now commonly made of manganese steel are:—Gears, pinions, sprockets, chains, dies, liners, wearing plates, rolls and rollers, railroad frogs and switches, and the crushing faces and digging parts of crushing and pulverising machinery, such as plates, dies, rollers and stamp-mill shoes.

The non-ferrous alloys of manganese have relatively small use and the amount of manganese ores necessary to supply them is not important. A review of the manganese-ore industry during recent years shows that, as heretofore, the greater part of the ores is consumed by the iron and steel industries.

Machinery for the Treatment and Mixing of Sands and Moulding Materials.

By Algernon Lewin Curtis, M.E.

(*Continued from page* 469.)

Having decided on a suitable sand store-house composed of the correct number of separate bins, each bin intercommunicating with its fellow, and the sand-treating machine, it then becomes necessary to consider constructive details of the machinery used for treating and mixing. Fig. 2 shows a general plan of a scheme for arranging sand bins and treating machinery for a large steel foundry. In this case sand stores and machinery are arranged on the west side of the foundry, the outside walls being bounded by a standard railway track running parallel to a canal. The south side is bounded by a further railway track which runs adjacent to the bins for treated sand. Accommodation for sand, etc., is provided in the bins A, B, C, D, E. A, B and C are used for different new sands, D for old sand, while E is for fireclay compounds, coal dust, steel moulder's composition or other materials not so extensively used as sand. The mixed or treated sand mixtures are stored in bins 1 to 6 inclusive, to which they are elevated by an elevator conveyor. Each of the bins A, B, C, D, E communicates with the central station, in which are situated four dumping hoppers, so any combination of materials up to four can be mixed and treated at one time. Old sand is brought from the foundry floor at night in side-tipping V-shaped 12-ft. or 16-ft. trucks which run under the treated-sand bins, and is then dumped into bin D. When returning, the operator can place his truck under any of the treated-

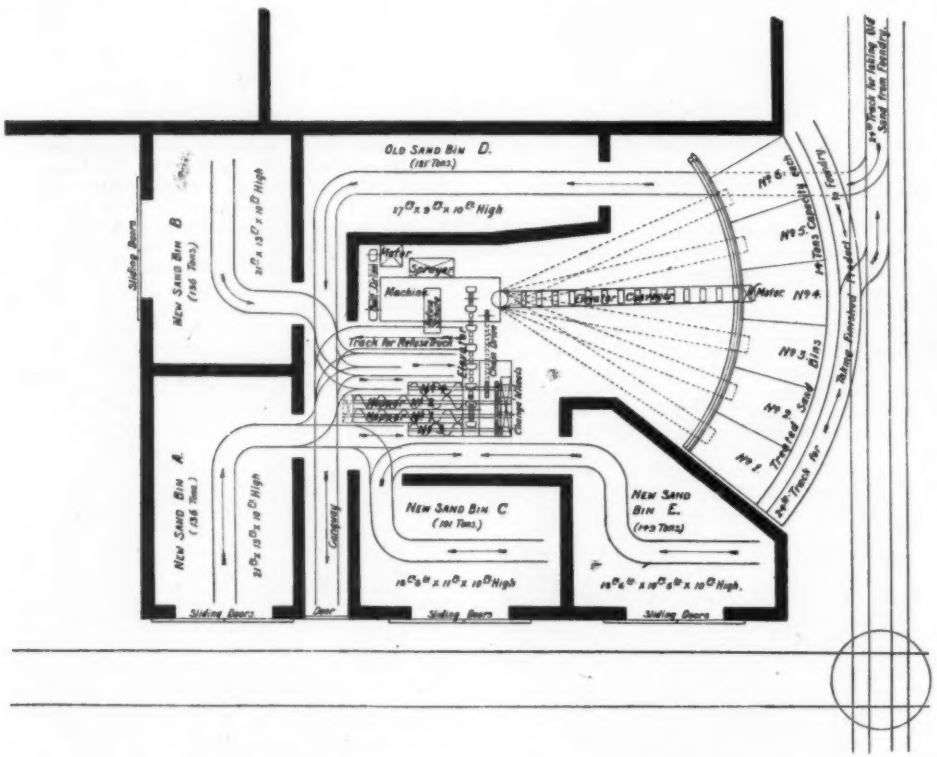


Fig. 2.—General Plan of Scheme for Sand Bins and Sand-treating Plant.

sand bins and return to the foundry floor with a full load. The details of mixing and treating machinery for use with such a plant will be described later.

The arrangement of any efficient sand-treating machinery necessitates provision for first accurately proportioning the various quantities of ingredients employed in any prescribed sand or moulding mixture, as it is not desirable to trust to unskilled labour for accurately measuring and mixing the requisite amount of various materials necessary for use in a

given sand mixture. As the number of different ingredients in any one facing mixture rarely exceeds four, such as two different new sands, old sand, with either coke, coal dust, sawdust, manure, or any other form of organic matter, provision must be made to accurately measure out automatically the correct quantities of either of these materials. This measuring, or proportioning, is best carried out by means of screw conveyors, each conveyor working in a separate compartment, while the mouths or exits of these compartments open into one common chamber or receptacle. It is rare that more than four separate compartment, while the mouths or exits each is arranged to suit proportions of material it is conveying. The speed of each conveyor should be so regulated by a series of change wheels that either conveyor can be set to run at any desired speed so as to feed the material into the mixing chamber according to the proportions desired by the foundryman for his different mixtures.

Before the proportioning of new or old sands can be effectively carried out, however, several matters

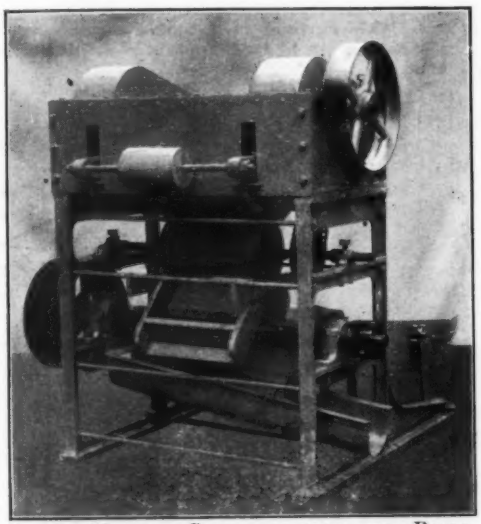


FIG. 3.—MAGNETIC SEPARATOR FITTED WITH ROLLS FOR BREAKING LUMPS IN OLD SAND.

must be considered. First, all new and old sands should be passed through rolls in order to break up any hard lumps which might have a tendency to remain unmixed or stick in conveyors and thus clog such machinery. Secondly, after passing the old sands through rolls, all metal drops, or fragments of iron, nails, chaplets and free metallic oxides must be extracted by a magnetic separator placed under and in close proximity to the rolls. The apparatus shown in Fig. 3, made by Messrs. W. Silversteen & Company, 147, Cannon Street, London, is an example of a separator fitted with rolls for breaking lumps in old sand.

Exciting current may be derived from either an existing electric-lighting main or from a small separate dynamo. The old sand should be dumped from side-tipping, V-shaped trucks into the hopper of the magnetic separator, which is, of course, let into the floor, and after passing through rolls has all magnetic materials removed. After separation the sand drops by gravity into proportioning hoppers in which the conveyors work. New sands, of course, do not require magnetic separation, which is, however, necessary with old sand desired to be used again. Some founders consider the small metallic residual matters present in old moulding sand after screening through a ¾ in. by 1 in. mechanical screen do not injure a sand mixture, and that the use of a magnetic separator is quite unnecessary, besides involving expense in operation. The author's experience, however, has been that small drops and fragments of iron and free metallic oxides are responsible for lowering and refractory qualities of old sand and steel moulders' composition 150 deg. to 350 deg. C., according to the amounts of such impurities and their mode of distribution. The presence of such impurities causes the metal to produce burned castings, and in some cases old sand gets into such a dirty state that it is cheaper to scrap the whole floor and begin with entirely fresh material than attempt to treat it. Many founders make a great mistake in using large quantities of old dirty sand full of free metallic oxides, besides still adhering to a large percentage of coal dust. Castings made in green-sand moulds from such mixtures are inevitably "cut," "burned" or "scabbed," because water or organic substances are the chief agents in holding the mould together. One of the best investments a founder can make is to submit samples of

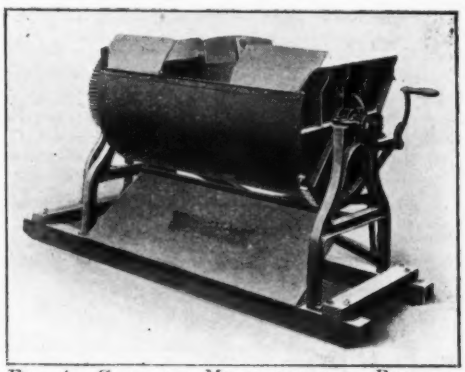


FIG. 4.—CORE-SAND MIXER READY TO RECEIVE SAND.

his old sand to an expert for examination and advice, because however good his new sands may be, if they are to be mixed with dirt, the dirt in the old sand will flux the new sand and lower the mixture's fusing point from perhaps 1,600 deg. to about 1,300 deg. C. The use and expense of a magnetic separator is therefore more than fully justified.

If the cost of screening and mixing by hand be added to the extra expense caused through "mending" moulds, plus the value of castings scrapped, it would exceed the cost of selected materials treated by special machinery. Although new sand does not require magnetic separation, it does at times require its strong clayey lumps broken to ensure complete incorporation, as well as to prevent such lumps from clogging the machinery used in mixing. Underneath each new sand-delivery hopper, above the conveyor, a pair of rolls should be placed so as to break up any lumps likely to be fed into the hopper. It is also desirable to place in the hopper itself a very wide mesh screen to prevent large stones from passing into the rolls situated below. After dumping the different new sands, old sand, coal, coke dust or other organic matters into their respective hoppers, accurate proportioning of these materials is carried on so long as the conveyors are kept covered, which is a simple matter to keep supervised.

When considering the advantages and disadvantages of mechanically-treated sand mixtures, the expense of transport must not be lost sight of, as it would be unwise to treat sands in an economical manner, then be at considerable expense in delivering the treated sand back to the moulder on the foundry floor. This difficulty, however, may be overcome by elevating the finished sand mixture into storage bins, then dumping it by gravity when required into side-tipping V-shaped trucks, so that the workman after bringing to the machine for treatment a full truck of old sand, can return to the foundry with a full truck of treated material. Such an arrangement always provides the moulder with a fresh supply of treated sand ready for use, and by removing the old sand at night or early morning it does not interfere with any other work in progress.

After proportioning the various materials necessary for use in a sand mixer, it is best to screen the whole mechanically, for although nails, drops and fragments of iron, chaplets, etc., have been taken out by magnetic separation, there are still present stones, pieces of wood and other substances which must be removed. These extraneous materials should be taken out by means of a revolving mechanical screen, the best position of which can scarcely be decided upon until after a survey of the actual conditions has been made. It is sometimes advisable to

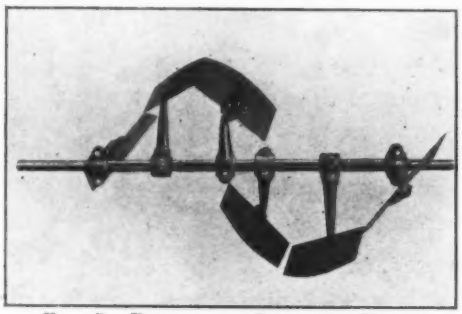


FIG. 5.—PADDLES OF CORE-SAND MIXER.

install screens in the vicinity of the feed hoppers, though generally, if room permits, it is better to arrange the screen over the mixing chamber, so that after screening the material can fall by gravitation into the hoppers; then small stones, pieces of wood, etc., are taken out through a refuse chute placed at the lower end of the screen.

The feeding of materials from the proportioning hoppers into the mixing chamber is a matter of some little importance and should be carried out mechanically if possible, as it is expensive to shovel sand by hand into a screen, especially if large quantities have to be dealt with daily. A good method is to provide an elevator fitted with suitable buckets set at such an angle that the buckets will by centrifugal force discharge their contents into a conveniently arranged shute which delivers the sand into the mouth of the mechanical screen. The latter should be set on a steep incline with its mouth at the highest point of delivery. The mouth of the revolving screen may be advantageously fitted with lifting blades to prevent sand coming back from the screen, and the taper given to the screen's axis should be such that small stones, pieces of wood and refuse are gradually propelled to a suitable shute placed for their reception. Directly the screen begins to revolve, the elevator buckets should discharge their contents, which, after being thoroughly screened, enter the mixing chamber.

After obtaining a product free from lumps, refuse, stones and metallic substances, it is necessary to employ the best means for "cutting over," or mixing and incorporating the various ingredients used. Many designs and types of machine are employed for this purpose, which include the pan or edge runner mill, down to the various types of centrifugal disintegrator. Vibrating machinery, sifters and mechanical screens, however, are not mixing machines and should be termed such, although they are often sold and used to perform the functions of such machinery. No type of machine can be termed capable of efficient mixing unless that operation is carried out under pressure.

The pan, or edge runner mill, is undoubtedly a good machine for crushing firebricks, silica rock, fireclay and ganister, and tempering loam, but on account of the difficulty of obtaining two batches of sand mixed and tempered alike, also the ability of such machinery to grind, thus reducing the silica particles to dust, this type of machinery is not best suited for the mixing of moulding sands. Even in steel-moulders' composition, which is made and prepared almost exclusively in pan mills, the dust content is excessively high, some steel moulders' compositions containing as much as 40 per cent. of their bulk

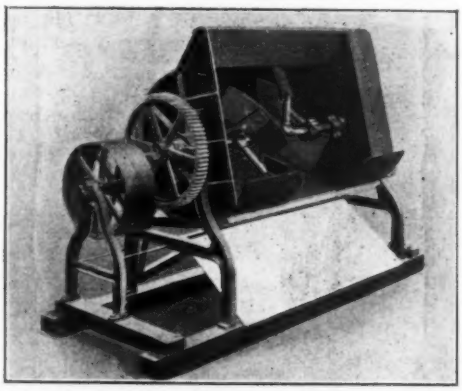


FIG. 6.—CORE-SAND MIXER DISCHARGING SAND.

small enough to pass through a 100-mesh sieve. The pan mill, in spite of its excellent advantages for use with other materials, may, therefore, be considered as not being the best type of machinery for preparing sand mixtures, although it is superior to mills of the centrifugal type.

The next most common type of machine employed for mixing sand is the vertical, or horizontal centrifugal mill or disintegrator, a type of machine too well known to need illustration here. As a disintegrator, spinner or spreader of sand this machine has several advantages, the sum total of which are its power of disintegrating lumps contained in either new or old sands. That it does partially mix materials put into it there can be no doubt, but the process is done without much pressure, so the correct "temper" necessary for a sand mixture cannot be obtained. An excess of water added to a weak sand mixture will make the latter temporarily cohesive (especially with the Red Rock sands of Lancashire), but this cohesive condition is soon changed to one of dry friability. Any founder can test the efficacy of a centrifugal mill by holding his hand at the point of discharge and every now and then feeling the character of the sand which has just passed through the mill. The product from

such machinery is not "flaky," as it should be for facing purposes.

It is not an excess of water which altogether promotes cohesiveness in a sand mixture, but rather the combined water of the clay substance. A moulding material can be made much more cohesive by mixing glycerine under pressure with the clay substance than by using an excess of water without pressure. Collodial properties of the clay substance can also be killed by addition of certain substances. Much better results can, therefore, be obtained by using a minimum amount of water with a correct proportion of clay substance in a facing-sand mixture, making the moistened clay substance perform the work of cohesion under pressure, than by quickly mixing materials without pressure, using too much water. Disintegrating machinery partially mixes very quickly, but not thoroughly, *i.e.*, the grains of silica or other minerals may be partly saturated with moisture, yet the clay substance will not have been properly "matured," owing to lack of pressure. The author's experience has been that facing-sand mixtures are more often than not dirty, weak, fritted, and damp, showing little temper and insufficient incorporation. A strong facing-sand mixture can soon be put right, but a dirty, weak, damp facing sand always causes trouble by breaking moulds, washing, scabbing and cutting.

Although the vertical and horizontal disintegrators or mills will always have followers, the products from such machinery will never compare with a sand mixture which has been correctly tempered under pressure by being passed through a pair of rolls. Perhaps disintegrating machinery like the above is better suited for dry-sand mixtures than for loam, green sand or cores, as not so much temper is required for the former. Very strong loam can, perhaps, be best treated and mixed by preparing it in a pan mill, but great care must be exercised during the operation.

With regard to core sands, small batches of this material should be mixed *en bloc*, *i.e.*, a definite amount of organic matter, like oil, core compounds, glutrin, etc., with water, should be mixed in an enclosed receptacle and cut over a large number of times. As there is often very little clay substance in sand used for cores, the mixture does not require the same temper as green-sand facings.

Fig. 4 shows a very useful type of mixer for small amounts of core sand. In this machine paddles are arranged as shown in Fig. 5, one set of which shovels the batch of sand to one end of the mixing chamber while the reverse set shovels it back again. By this means the sand is cut over twice at each revolution, and as the speed of the paddles is 20 r.p.m. the sand is thus cut over 40 times a minute and thoroughly incorporated. Fig. 6 shows the machine when discharging its contents, which can be done without stopping, the revolving paddles scraping out the finished product.

(*To be continued.*)

Bauxite Bricks for Refractory Purposes.

According to a bulletin issued by the United States Geological Survey, dealing with the various uses of bauxite, the use of that material in the manufacture of bauxite brick for furnace linings has long been considered. It has been found by experiment that when the impure forms containing considerable iron oxide are exposed to intense heat, the bauxite is converted into a solid mass of emery of such extreme hardness that it can barely be cut by steel tools and that it resists chemical, thermal, and mechanical action to a marked degree. The purer the bauxite used the more refractory it is, and the addition of bauxite free from iron oxide to refractory clays increases their alumina content and at the same time their refractoriness. The high cost of the raw material, as well as of the manufacture of the bricks, makes the ultimate cost of bauxite bricks high compared with the cost of silica or fire-clay bricks. Recent applications of bauxite in bricks are in the lining of rotary cement kilns, lead-refining furnaces, and basic open-hearth steel furnaces, where a brick high in alumina and low in silica is required. Recent tests seem to show that bauxite bricks are suitable for basic open-hearth furnaces, provided they can be made with less than 12 per cent. silica; and experiments show that bricks with this low proportion of silica are as good as magnesite brick.

In preparing bauxite for use in kiln or furnace linings, the crude ore is first washed to remove some of the free silica and clayey impurities. It is next calcined at a temperature of 2,500 deg. F., and during this process it gives off its water of constitution, amounting to about 30 per cent. of the raw ore, and undergoes great shrinkage in the meantime. In the calcination of bauxite according to modern methods rotary kilns are employed in which oil, gas, or powdered coal are used as fuel. It has been observed that the bauxite shrinks very little below a temperature of 2,390 deg. F. Between this temperature and 2,500 deg. F. the greatest shrinkage takes place. Accordingly, the lowest temperature at which bauxite should be calcined is about 2,500 deg. F.

The calcined mineral may be bonded with fire clay, sodium silicate, or lime. As little as 4 per cent. of plastic fire clay may be used as a bond in hand-made brick. When bonded with lime the bricks become so hard a few hours after making that they will not take the impression of the finger nail. This setting or hardening is probably due to a reaction between the lime and the free silica whereby calcium silicate is formed, and the reaction may be analogous to that involved in the setting of silica bricks when bonded with lime. After a careful drying the bricks are burned in down-draft kilns at a high temperature, becoming hard and tough. A brick 9 by 2½ by 4½ inches weighs 7½ pounds and stands a crushing test of 10,000 pounds to the square inch.

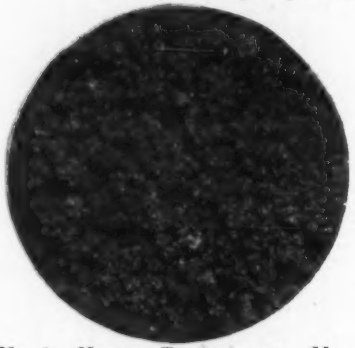
According to Kenneth Seaver, the early troubles in the use of bauxite bricks were due largely to deficiencies in the bonding material, to insufficient calcination of the raw stock, and to the attempt to burn the bricks at too low temperatures. A high-grade bauxite brick should contain 56 per cent. of alumina, or still higher where conditions warrant. The term bauxite brick is somewhat loosely applied, and the alumina content varies within considerable limits, many of these brick containing only 43 to 51 per cent. of alumina. If properly made the brick is physically strong and tough, but has a tendency to spall in the arches if suddenly cooled or heated. A representative analysis of bauxite brick is given below:—

Silica (SiO_2)	28.38
Alumina (Al_2O_3)	56.70
Iron oxide (Fe_2O_3)	2.95
Lime (CaO)	—
Magnesia (MgO)	1.09
Alkalies	0.88
	100.00

FOUNDRY SANDS AND THEIR TREATMENT: TESTS FOR REFRACTORY VALUES.

By Algernon Lewin Curtis, M.E.

Material Tested :—**STAFFORDSHIRE SAND.** *Weight of Sample* :—100 Grammes. *Colour and Description* :—Very Dirty Dark Reddish Brown. *Consistency* : Weak, Fine. *Surface Factor or Size* :—(Grammes per cent.)—Retained on 50 Sieve, 0.270 ; Retained on 100 sieve, 34.870 ; Sieved Through a 100 Sieve, 64.860. *Water required for Maximum Cohesiveness when dried one Hour at* 100 *Deg. Cent.* :—Six C.C. per cent. *Venting Capacity of* 1 *Cub. In. when Mixed* 400 *Times with* 6 *per cent. Water and Rammed at a Pressure of* 25 *lbs. per Square Inch* :—About 4 lbs. air pressure. *Plate* :—Wellington and Ward, "Anti Screen." *Objective* :—1 in. Watson.



No. 1.—Normal Temperature. Mag. × 50 Diams.

Remarks.—Material Works Fairly Well in Moulds, owing to being Fine and Packing Tightly. Large Quantities of Free Mica Visible in Sand. Material takes too much Water.

No. 2.—Exposure to 1,200° C. Mag. × 50 Diams.

Remarks.—Test Piece Expanded $\frac{3}{64}$ in. in the Form of a Camber in a Length of 2½ in. Specimen Strong and Unbroken by Heat. No Exfoliation. Bleaching of Test-Piece space Begun.

No. 3.—Exposure to 1,300° C. Mag. × 50 Diams.

Remarks.—Test Piece Expanded $\frac{4}{64}$ in. in the Form of a Camber in a Length of 2½ in. Specimen Strong and Unbroken by Heat. No Exfoliation, but Smaller Grains Commenced to Fuse in the Form of Bunches or Aggregates.

No. 4.—Exposure to 1,400° C. Mag. × 50 Diams.

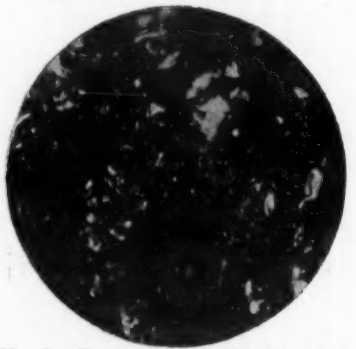
Remarks.—Test Piece Expanded as in Fig. 3. Specimen Strong and Unbroken by Heat. No Exfoliation, but Surface of Test Piece Fused to Larger Bunches or Aggregates, showing Heavy Pitting and Fissuring.

No. 5.—Exposure to 1,500° C. Mag. × 50 Diams.

Remarks.—Test Piece Expanded $\frac{1}{16}$ in. in the Form of a Camber in a Length of 2½ in. Specimen nearly Fused to a Dark-Yellowish Glass. Test Piece Strong and Unbroken by Heat, showing Heavy Pitting and Fissuring.

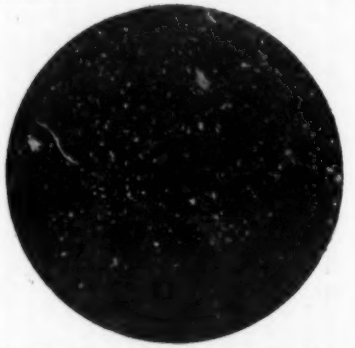
No. 6.—Exposure to 1,600° C. Mag. × 50 Diams.

Remarks.—Test Piece Expanded $\frac{5}{32}$ in. in the Form of a Camber in a Length of 2½ in. No Exfoliation. Specimen Strong, Unbroken by Heat, and nearly Completely Fused to a Dirty-brown Slag, showing Heavy Fissuring and Pitting.



No. 7.—Exposure to 1,700° C. Mag. × 50 Diams.

Remarks.—Test Piece Broken by Heat. Specimen Weak, slightly Exfoliated, and Fused to a Dark-brown Slag, Heavily Fissured and Pitted.



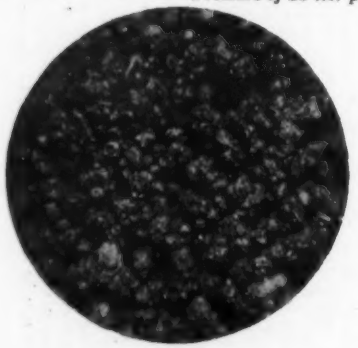
No. 8.—Exposure to 1,800° C. Mag. × 50 Diams.

Remarks.—Test Piece Broken by Heat. Completely Fused to a Dark-brown Slag Loaded with Impurities and Heavily Pitted.

AND FISSURING.

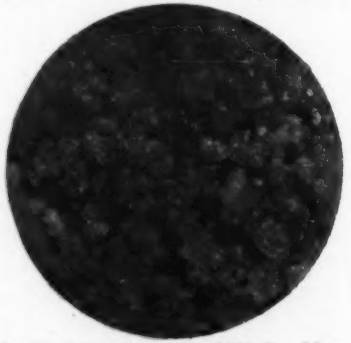
SLAG, SHOWING HEAVY FISSURING AND PITTING.

Material Tested :—**NOTTINGHAMSHIRE SAND (Worksop).** *Weight of Sample :*—100 Grammes. *Colour and Description :*—Medium Dark Brick Red. *Consistency :*—Fine, Medium Strength. *Surface Factor or Size :*—(Grammes per cent.)—Retained on 50 sieve, 0.220 ; Retained on 100 sieve, 56.820 ; Sieved through a 100 Sieve, 42.960. *Water required for Maximum Cohesiveness when Dried one Hour at 100 Deg. Cent. :*—Five C.C. per cent. *Venting Capacity of 1 Cub. In. when Mixed 400 Times with 5 per cent. Water and Rammed at a Pressure of 25 lbs. per Square Inch :*—About 7 lbs. air pressure. *Plate :*—Wellington and Ward, "Anti-Screen." *Objective :* 1 in. Watson.



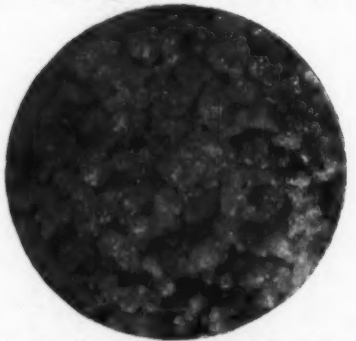
No. 1.—Normal Temperature. Mag. × 50 Diams.

Remarks.—Material Worked Fairly Well in Moulds, being a Trifle Gritty. A Small Percentage of Free White Mica Visible in the Sand.



No. 2.—Exposure to 1,200° C. Mag. × 50 Diams.

Remarks.—Test Piece Expanded $\frac{1}{32}$ in. in the Form of a Camber in a Length of 2½ in. Specimen Strong and Unbroken by Heat. Smaller Grains begun to Fuse in Fine Aggregate.

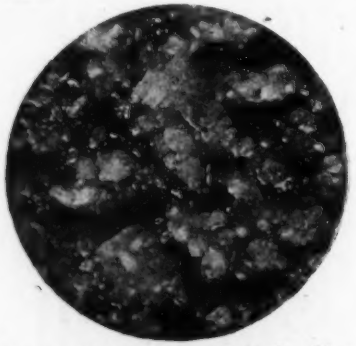


No. 3.—Exposure to 1,300° C. Mag. × 50 Diams.

Remarks.—Test Piece Expanded $\frac{1}{16}$ in. in the Form of a Camber in a Length of 2½ in. Specimen Strong and Unbroken by Heat. More Fusion taken place of Smaller Grains in Large Aggregates, showing Slight Fissuring.

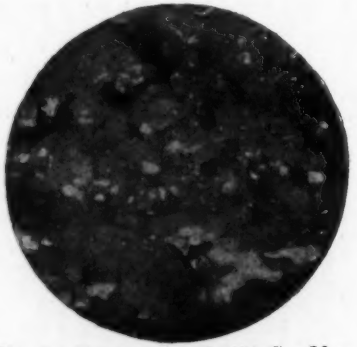
No. 4.—Exposure to 1,400° C. Mag. × 50 Diams.

Remarks.—Test Piece Expanded as in Fig. 3. Specimen Strong and Unbroken by Heat. Material Partly Fused in Thick Bunches or Aggregates, showing very Heavy Fissuring.



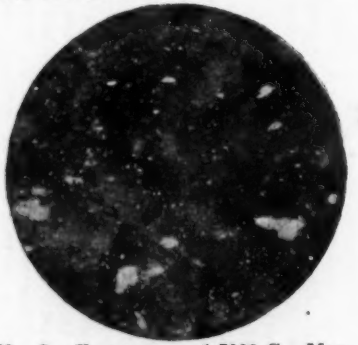
No. 5.—Exposure to 1,500° C. Mag. × 50 Diams.

Remarks.—Test Piece Expanded as in Fig. 3. Strong and Unbroken by Heat. Material nearly all Completely Fused to Dense Masses, showing Deep Fissuring due to Presence of Iron.



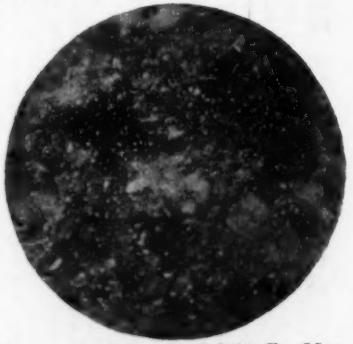
No. 6.—Exposure to 1,600° C. Mag. × 50 Diams.

Remarks.—Test Piece Broken by Heat. Specimen Strong, showing no Exfoliation. Material Completely Fused to a Dirty-whitish Yellow Glass, Full of Pits and Fissures.



No. 7.—Exposure to 1,700° C. Mag. × 50 Diams.

Remarks.—Test Piece Expanded ⅛ in. in the Form of a Camber in a Length of 2½ in. Specimen Strong, showing no Exfoliation. Material Fused to a Dark Yellow Glass, Heavily Fissured and Pitted by Iron, etc.



No. 8.—Exposure to 1,800° C. Mag. × 50 Diams.

Remarks.—Test Piece Expanded $\frac{3}{32}$ in. in the Form of a Camber in a Length of 2½ in. Specimen Strong, showing Slight Exfoliation. Material Completely Fused to a Dark Yellow Glass, Fissured and Pitted with Iron.

Core Boxes and Core Making.

By D. Gordon, A.M.I.Mar.E.

The tendency in the foundry to-day appears to be in the direction of drying all work previous to casting. As is to be expected, the inevitable result of this procedure is that cores are now more frequently adopted, and in many cases those portions of a pattern which previously would have been expected to leave their own, are now cored. The advantages or disadvantages that may arise from this apparent superfluity of cores are, admittedly, controversial; but it is invariably conceded that cores properly secured, dried and vented, are the source of little danger and economically preferable to the mending up of a badly fractured mould, with the ever possible dangers due to imperfect mending.

In considering the full extent of a core's utility, it must be judged from the points of view of both necessity and convenience. The requirements may be broadly summarised as follows :—

(1) To give shape or form to a casting's interior.

(2) To add to certain parts of a mould any required form which cannot be obtained by means of a pattern "lift," drawback, or the loose piece of a pattern.

(3) To facilitate moulding to a greater degree than is possible by the pattern only.

Under the first two of the above headings necessity leaves no choice about a core's adoption, the chief considerations in these cases being the means whereby the core can be most economically produced consistent with the nature of the work in hand. In the third instance, however, as its uses may be optional, the governing conditions whereby a mould may produce sound castings has to be considered, and if by the adoption of cores this end is assured, it becomes economically an advantage.

Owing to the value of a core being determined by the cost of its production relative to (*a*) the advantages gained by its use, and (*b*) its necessity, the ways and means whereby cores are produced are of interest and value, as are also the constructive principles involved in the chief means of producing them, *i.e.*, core boxes. The latter is important, as in the making of the many and varied types of boxes used there is often a lack of appreciation of constructive principles, coupled with an apparent ignorance or neglect of the natures of the materials used. This is the more surprising when one considers that in the majority of cases a core box is required to withstand no inconsiderable amount of rough usage, which tests its strength and durability to no small degree. The term "rough usage" is used in the sense as applied to the ramming, rapping, parting or loosening of a box. incidental to a core's removal.

Cores are primarily sand structures possessing refractoriness to the degree of withstanding the searching actions of fluid metals at various temperatures, porosity to allow the free escape of generated gases, and cohesiveness to partake and retain form, which properties are common to the mould in conjunction with which the cores are used. Their formation is obtained by means of boxes, strickles, sweeps, or guides, the character of the work defining the method to be adopted for their production.

The most common means of producing cores is by the use of core boxes, which are essentially moulds formed of wood, metal, plaster-of-Paris, or any material that can retain form and resist pressure. In the majority of cases metal is only utilised when the work is of a standard or stock character, or alternatively when a duplicate box is required to replace a core box of fragile nature. The initial expense of such boxes prohibits their general use, as a double cost has to be considered for their production, and a pattern core box after being cast in metal, has to be converted into the core box proper, which usually entails various machining processes. Further, the weight would in many cases be excessive, which fact curtails the use of metal for boxes of the larger varieties.

Plaster-of-Paris is used when the number of cores required is small, or as a pattern box for reproduction in metal, when by its adoption the initial cost can be considerably reduced. The chief disadvantage of this material is its liability to fracture, but durability is a secondary consideration in these cases.

Wood, which is the most commonly employed of any material for core-box production, is suitable chiefly by reason of its lightness, adaptation to either hand or machine-tool processes, and its durability, which is dependent upon the variety used. The kinds of timber used are many, but in core-box practice the following are most commonly utilised :—Yellow pine, Honduras mahogany (commonly called baywood), bass or American whitewood, teak, white deal (spruce), and oak.

Yellow pine is the most commonly used of any wood for the making of core boxes, as it possesses those qualities which make it eminently suitable for this class of work; it is straight in the grain, soft in working, thus adopting itself to hand-tool processes, does not unduly twist or warp, and also takes glue well.

Honduras mahogany is a much tougher wood and obviously takes longer to work up to shape, but produces a fine surface finish—no mean consideration where durable, smooth surfaces are required. Its price being usually prohibitive for general use, its uses are confined to the smaller types of boxes, loose pieces, facings, and the rapping surfaces of the larger boxes. Being much closer in the grain than pine it is not acted upon to the same extent by moisture, and is thus very suitable for use when the work is of a standard or repetition class.

American whitewood is often used as a substitute for pine, but is more liable to twist and warp than the latter. It is classified as a "hard wood," but is extremely easy to work up, and for work of a carved character is preferable to pine and a surface furnish equalling baywood is obtainable; but, as already mentioned its uses are limited owing to its liability to twist and warp.

Teak is used for the same classes of work as specified for baywood, but is far more durable, being able, owing to its resinous nature, to resist to a very considerable extent the effects of moisture. Core-boxes, loose pieces, etc., made in this material are costly to produce, as tools are blunted very considerably during its working up to shape.

Spruce is used only when the work is of a plain or rough character, considerations of economy chiefly influencing its use. It is very liable to twist, split and warp, and is thus only employed within the narrow limits of the "one off" variety.

Oak is used chiefly for the framings and plain hard-wearing surfaces of standard boxes of the heavy variety. It is very rarely used for work of a carved nature, as mahogany or teak produce a more satisfactory finish than can be obtained by its use. Owing

to its extreme durability its uses for frame core-boxes should be more general.

In considering the construction of any type of core-box, primary consideration has to be given to the most convenient method for the core's removal, and in this respect the box must be treated as a mould—which in reality it is—for formulating sand to a defined shape. For the simpler cores this consideration is of little moment, but for work of an intricate character a very difficult problem has often to be solved, and in many cases the best way is only discovered after the box has been made.

For constructing the general run of simple core-boxes, as, for example, the common square, round, or the modification of either, the principles in every case hold good. Taking first boxes for cores of square or oblong section, these are, when split, parted diagonally, this obviously being the most convenient method of freeing the core from the box. Fig. 1 gives an example of one of these boxes, the illustration indicating the run of the grain which, it will be noted, is in the direction of the cut. When made in this

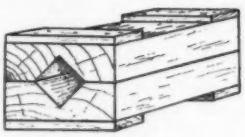


Fig. 1.

manner the box length is usually over 11 in., but when under this size the cut is usually transverse to the grain. This tranversely-cut form of box has a harder wearing surface, as the grain of the wood is cross-cut, and when fully battened makes the strongest form of boxes of this type. Its formation takes slightly longer than a box cut with the grain, and for this reason its length is, in the majority of cases, confined within the limits of an 11-in. board, to obviate the necessity of glueing up for the greater widths. In the case of boxes cut with the grain, any reasonable length is obtainable without jointing and is quickly formed to shape. Such boxes are not as a general rule fully battened across their backs, strong end battens (Fig. 1), securely attached by screws, being all that is necessary to prevent the box "winding," as in its width it is comparatively narrow—this as distinct from the transversely-cut box where the full batten is a necessity to prevent the winding of the greater width in its transverse direction.

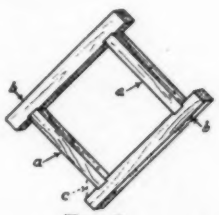


Fig. 2.

For making the larger square or oblong core-boxes of smaller sectional thickness, framing up is usually resorted to, as shown in Fig. 2, where, it will be noted, the ends *a*—*a* are housed into the sides, screws passing through these latter securing the whole in position. These boxes are pierced through the ends or sides, to allow the vent wires to be withdrawn from the core. This type of box is very rarely required to part for the core's removal, the rapping usually giving sufficient clearance to allow this, but when parting is more convenient the screws at *b*—*b* are removed and the sides and ends in each case drawn back, being, after the rebated portions have been cleared, diagonally parted. End blocks, as indicated at *c*, are glued into the corners, not detachable, to give increased rigidity.

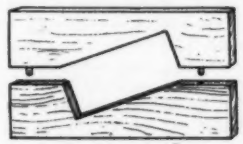


Fig. 3.

In Fig. 3 the method commonly practised for making the smaller types of these boxes is shown, the required form being cut from the solid material and jointed diagonally, dowels defining the respective positions of each half-box. A common mistake made with boxes of low sectional thickness is to make them up upon a bottom board, which entails the turning over of the core upon the core-plate, preparatory to placing in the stove for drying. This, of course, is obviated when they are left open and is an economical consideration, especially if the output required is large. For making cores of an odd size but of a more or less standard nature, boxes are usually made up to contain three or more of differing sizes. The number depends upon the convenience for handling.

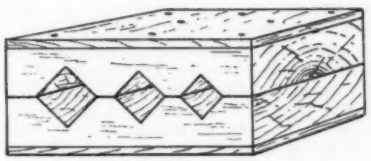


Fig. 4.

The cuts are made transversely with the grain, as shown in Fig. 4, the core length not exceeding 11 in.

Boxes over 3 in. square are as a general rule framed together, being made open top and bottom. In many cases parting precautions to free the core from the box are unnecessary, as these cores are usually of the "drop out" variety, i.e., the rapping gives sufficient freedom to allow of the box being lifted off and cleared. When this is not convenient they are made to relieve, as shown in Fig. 5, corner blocks as *c*

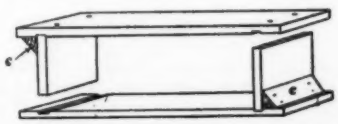


Fig. 5.

giving added stability to the ends, which are housed into the sides. When venting is required in a longitudinal direction, the ends are perforated for this purpose. For repetition work of a standard or stock variety, metal boxes are frequently adopted and in Fig. 6 a common form of metal box is shown. It is parted diagonally, the joints having registered flanges for defining position, which position is secured by means of the bands *c* which fit over the box ends, a slight taper at these positions facilitating

their easy adjustment and removal. The registered flanges in this case only prevent lateral movement, as the piece *x*, Fig. 6, only fits into the flange *y* without any means of security in the longitudinal direction, but this can be obtained by means of a boss-and-pin arrangement as will be explained for circular metal boxes, when the iron bands *c* are only required to prevent the ends splaying out during the ramming up of the core. Another method often adopted for this type of core-box is to hinge the points upon one side, and securing the other by means of intermediate bosses upon each half box, these boxes being drilled to receive a securing bolt passing through them.

The core-boxes for making the larger or heavier types of square or oblong sectional cores are invariably framed together, the purely constructional principles involved being in nearly all cases the same. In Fig. 7 the chief points of construction are shown, where it will be noted that the end pieces *a*—*a* are

FIG. 6.

housed into the sides *b*—*b*, the rebating offering that stability and rigidity which is so necessary when diagonal support is not obtainable. This rebating, or more properly speaking "housing," should not, in depth, be less than $\frac{3}{16}$ in. as the lateral support is as necessary as the definition obtained by this constructive method. By means of screws passing through the side pieces into the ends a common but weak means of attachment is obtained, and on this account should not be adopted when the number of cores required is at all considerable, and it is found more convenient to part the box by unscrewing the ends for the core's release. The reason which chiefly tends to make this a bad form of attachment lies in the fact that the screw "loses its thread" in the end grain, owing to being continually relaxed, and continual

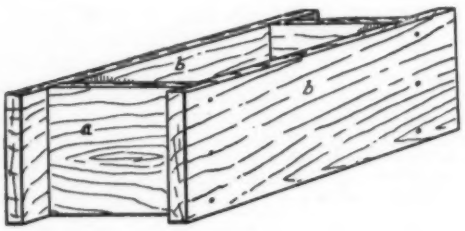


FIG. 7.

countersinking of the screw-head to obtain a further "bite" has its limitations. This losing of the thread is perfectly obvious and to be expected if consideration be given to the nature of the wood, which being composed of masses of fine cellular tissue, tapering in a longitudinal direction with the grain, are drawn apart by means of the screw helices. To explain this more clearly, and to emphasise a feature common to all timbers, which though often not understood or known, yet is the cause of many cases of weak construction, Fig. 8 is given. This shows the magnified view of a piece of common timber, the arrow *x* indicating the end grain and showing clearly the cellular composition in this direction of its prismatic form. The tapering wedge-like ends *c* in the lengthwise direction of these cells will obviously tend to draw apart if a screw be drawn in the direction of *x*, a tendency which always occurs, if not always to a very appreciable extent, this being proved by the fact that a screw, supposedly tight-fitting, on being withdrawn always carries with it some of this cellular tissue. If, on the contrary, screws be driven in the direction of *a* these cells become impaled, but the tapering ends offer a wedge-like resistance, thus the maximum of strength for attaching by means of screws is in this direction. The smaller transverse cells, as at *m*, are the medullary rays which show

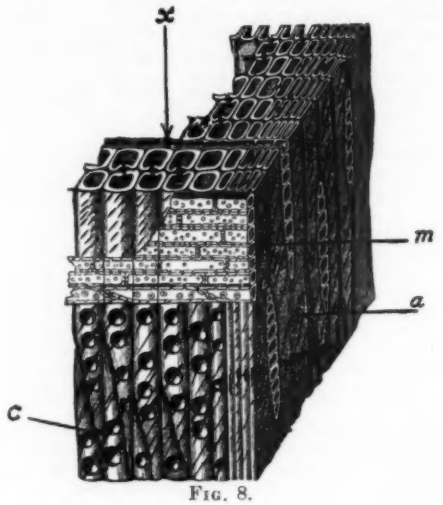


FIG. 8.

themselves—especially in the harder woods—upon the surface, being familiarly known as the "silver grain" or "flower"; they are sectionally much smaller, without the wedge-like ends, thus offering a firmer hold than the cells in the direction *x*, owing to the screw grip being distributed over a greater area.

From the foregoing it follows that if a stronger means of attachment be required than can be obtained by fixing into the end grain—as for the example Fig. 7—this may be obtained by fixing end

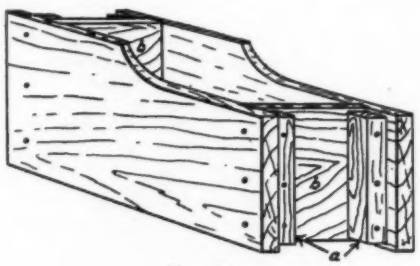


FIG. 9.

blocks to the end pieces, the grain of the end blocks running transversely to the end pieces. In Fig. 9 this method is shown, the blocks *a* being screwed to the end pieces *b*, *b*, and receiving the screws which pass through the sides into them. For core-boxes of a standard or repetition order, when the dismantling of the ends and sides is required, clamping bolts are very frequently used in preference to the ordinary wood screw, which, by its continual removal, is apt to wear considerably at the head. These clamping bolts *a*, Fig. 10, pass through the sides, which are

strengthened by means of batten *b*, and at one end are flanged, at the other being screwed to receive a clamp handle *c* which when screwed up binds upon a washer *d*. The side of these bolts are in close contact with the faces of the end pieces, thus preventing any lateral movement, the tightening up of the bolt bar and handle ensuring a very firm means of attachment, at the same time giving every facility for quick and easy dismantling.

When cores are made from boxes which are open top and bottom, they are preferably rammed upon

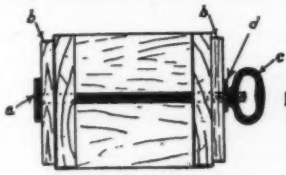


FIG. 10.

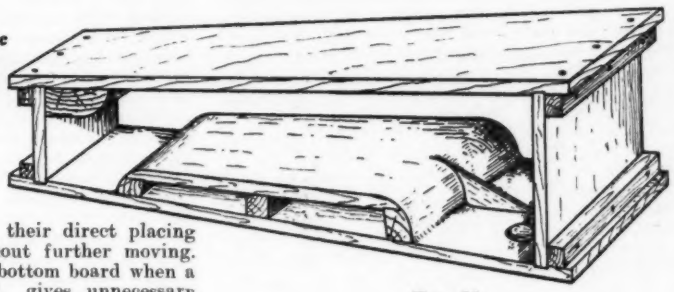


FIG. 11.

the core-plate, which allows of their direct placing into the stove for drying without further moving. The mistaken idea of making a bottom board when a flat surface only is required, gives unnecessary trouble, as the work has either to be turned over or slid upon the plate for drying, this latter method usually entailing mending of the cores. Bottom boards are only really necessary when they are required to give formation to the core upon another plane, which form cannot be attained by strickling. In the example, Fig. 7, the ramming up of the core in the position shown and upon a flat core plate ensures the correctness of the bottom flat surface; the upper surface is strickled level with the box sides by means of a straight-edge, and sleeked over, which gives the satisfactory form to the core and requires no disturbing after the box has been removed. This method would also apply to Fig. 9, the one irregular top surface being struck to shape in the same easy and efficient manner. In Fig. 11 the same considerations prevail, the irregularities of the core being made upon the box sides, these latter being drawn back and away from the core after the releasing of the attaching screws. The upper surface only would be required to be struck level. Too much attention cannot be given to considerations for the removal to the stove, which, although of apparently little moment in the case of the smaller types of cores,

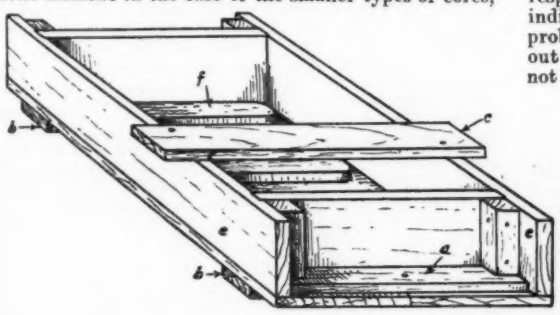


FIG. 12.

become in the aggregate costly, and in the case of the larger or heavier cores unnecessarily expensive.

When it is necessary to utilise bottom boards or plates, they are usually made to work loose from the frames, register strips *a*, Fig. 12, defining and keeping their position. These strips abut against the faces of the end pieces and are, in length, sliding fits between the box sides. In many cases they are made to also act as battens for the bottom board to prevent this latter warping, but battens as *b*, *b*, can preferably be made thicker to ensure greater stability, which in the case of the strips would be a disadvantage owing to the increased friction between them and the frame not allowing that desirable freedom of removal so necessary in work of this description. Dowels are sometimes used for registering purposes, but possess no advantages over the register blocks, and when used battens become essential for strengthening purposes. When projections, such as bosses, facings, etc., are required and which cannot be strickled out, these are usually attached to a carrying board *c*, Fig. 12, the position of which is defined by dowels fitting into the box sides. During the ramming up of the core this board is kept rigid by one or more screws fixed into the frame sides. Fig. 13 gives the end view of

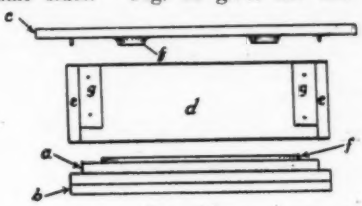


FIG. 13.

this box with the items shown apart, *a* being the register strip, *b* the batten, *c* the carrying board, *d* the one end piece, and *e*—*e* the sides. At *f*—*f* the respective projection pieces upon both boards are indicated. In narrow core-boxes the frame in all probability would be lifted clear from the core without having to dismantle it in any way, but this does not do away with the necessity for the corner blocks *g*,

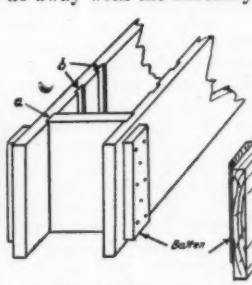


FIG. 14.

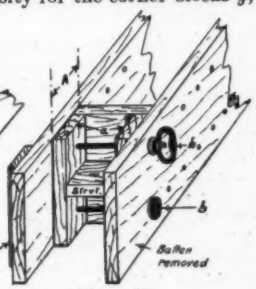


FIG. 15.

as will be readily understood when a constructionally sound box is required.

Some classes of framed core-boxes are required to be easily extensible as the cores sectionally are the same throughout, but their lengths always varying. These are frequently made to length by housing in one of the end pieces into the sides at the required

positions. This method has a deteriorating effect upon the box, as the partitioning pieces between the various housings become so weak that they break away, and the advantages gained by housing are lost. Further, the continual screwing and unscrewing into the end extension piece necessitates many holes in the sides, which tends to weaken these very considerably. In Fig. 14 a box of this type is shown. The weakening effects that must take place if the end piece *a* be made to intervene between two previously housed positions as *b* will be readily understood. For boxes of this description it is advisable to do away altogether with the housing in principle for the movable end piece, and preferably depend upon a butt joint where the ends come into contact with the sides. When this method is adopted bearing runners *a*, Fig. 15, should form part of the extension piece. These bearers keep the movable end at its required angle with the sides and clamping bolts *b*—*b* passing through the whole maintain the position. If the box sides be perforated to take the bolts at positions most commonly required for the different standard extensions and clearly marked, the question of extension is a matter of little trouble and moment. When odd-length cores are required, which may mean the disturbing of a standard hole by the further boring of another contiguous to it, the bolts should be discarded and ordinary screws through the sides into the bearers be utilised for positioning. The length A of the end pieces should give sufficient bearing without being excessively long.

In all framed-up boxes of the larger types where jointing of the material is necessary, these joints should in all cases be made "open"—$\frac{1}{8}$ in. being the common practice—to allow free movement for those swelling or shrinking actions which are inseparable from wood, thus preventing the inevitable splitting or distortion if this precaution be ignored. This also applies to bottom boards or plates, as in all cases these actions of the material are accentuated by the moisture absorbed from the sand and the varying temperatures to which they are subjected.

Foundrymen's Visit to Works of the General Electric Company.

On Saturday, July 25, a visit was paid by members of the Birmingham Branch of the British Foundrymen's Association to the Witton Works of the General Electric Company, Limited. The party was received by Mr. H. Mather, manager of the foundry and pattern department, and Mr. Morgan, and a general inspection was made of the works.

The Witton Works, forming one of the largest factories in Birmingham, stand upon a site which fourteen years ago was meadow-land. With the development of the works, accommodation for the employés has sprung up in the surrounding district. The works stand upon an area of 120 acres. The larger electrical apparatus is made in the main building, which is 350 ft. long and 210 ft. wide. The large engineering shops have two well-lighted bays, each served by two electric cranes. Throughout these and all the other shops the machinery is electrically driven. The power is generated by a Witton continuous-current turbo-generator, and two smaller machines driven by reciprocating engines. The buildings also include large stores. On the other side of the approach are the Witton Carbon Works.

Amongst the machinery in the engineering shops were seen the Witton-Kramer electric drills and lifting magnets. It was explained that with the aid of the magnetic drill post, the electric drill has revolutionised constructional work, enabling drilling work to be accomplished without the usual trouble of rigging up drilling tackle. The magnetic drill post holds itself down to the work to be drilled and enables the drill-head to take a bearing and to press down upon the work. Among the recent additions to the engineering plant is a planing machine of new design by Loudon Bros., Limited, for planing large castings. The machine will take anything up to 14 ft. by 8 ft. and will cut to a depth of $\frac{1}{2}$ in.

Near the engineering shops are the switchgear works, in which are manufactured gear ranging from house-service switches to the largest motor starters and controllers. Explosion-proof switchgear for colliery purposes has recently been receiving special attention from the Company. The switchboard gallery, which is over one end of the engineering shops, serves for the erection of all sizes of switchboards. One recently completed is a 45-ft. board containing 25 panels, for a large Welsh municipality. The electrical conduit works, with a special tube-drawing plant, adjoins the engineering block and forms a very important department. The works at Witton employ altogether about 3,000 hands, and the total number of workpeople. Extensions of the works are in contemplation which will add 50 per cent. to the productive capacity of the engineering department, and the other departments, including the foundry, will be proportionately extended.

In the foundry there are at present about 100 men employed, in addition to about 30 pattern-makers. All the castings made are for use in the works, and every casting for electrical purposes is made on the premises. Very many of the castings run up to 15 tons, but the visitors saw a mould and core which had just been made for a casting of 22 tons, to serve as a casing for a large turbo-generator.

In the adjoining light foundry, castings are made from an ounce upward. A great deal of the small work is made on moulding machines, the "Adaptable" and the "Farwell." The castings for fan work range from 1 oz. to 12 lbs., whilst a great deal of delicate moulding is required for such articles as switch boxes and starter boxes, the castings for which are in many cases less than $\frac{1}{8}$ in thick. The cupola is about 3 ft. in diameter, and with a capacity of about 8 tons per hour. The blast is supplied by a Root's blower. The foundry is divided into two bays, each about 140 ft. by 60 ft., the one being allocated to heavy and the other to light castings. In the heavy foundry there are two overhead travelling cranes, one 15 tons and the other 5 tons, and in the light foundry a travelling crane of 15 tons lifting power. The sand used is partly that found on the Company's property at Witton, which is an ordinary open red sand, whilst the finer red sand is obtained from Wolverhampton. For standard work metal patterns are mostly used. The pattern shop is on an upper floor in an adjoining building, but at the end of the foundry is a large pattern store which is used also as a repairing shop for the heavier patterns.

The visitors were entertained, on behalf of the directors, at tea in the Magnet Club, the social headquarters of the staff. It may be noted that the directors, who show a great interest in the social life of their workpeople—as is evidenced by the large amount of ground laid out for sports purposes—intend to erect a large building as a club-house for the staff and workmen. This building, which will cost about £10,000, is intended to be the most up-to-date establishment of its kind.

Aluminium Foundry Notes.

Aluminium being an infant among commercial metals, is to the great majority of engineers and founders a little-known and doubtful quantity; while even to many who have nursed it spasmodically it presents sufficient vagaries of conduct to excite suspicion. But, all the same, there might be applied to this infant metal the famous description which was applied to the human infant, "a bundle of latent possibilities." It can truly be said that the possibilities of the metal are largely dependent on its treatment, and it is not a matter of surprise if in unskilled hands it gives at times some trouble. But the knowledge of how to deal with aluminium and its alloys is rapidly increasing among foundrymen, so that it can be safely predicted that the wide application which has been found possible for the rolled and drawn pure metal will be closely followed by a similar wide application in the casting world. It is not yet regarded as probable that there will be ultimately an "aluminium age," in the sense that there has been a "bronze age," and there is now what might rightly be termed the "iron age," but nevertheless the abundant existence of the element in nature (not pure but in combination with other elements) certainly suggests that there is a resource of material for the future which is at present relatively only in the experimental stages. It will, of course, be understood that aluminium has in the literal sense of the term passed the experimental stage, so far as proving a wide applicability is concerned.

It is perhaps elementary to recall that aluminium occurs as a silicate in clays, felspar, etc., but is chiefly extracted from bauxite, an impure hydrated oxide, and also cryolite, the double fluoride with sodium, $Na_3 AlF_6$. Bauxite is the chief source of the European production of aluminium. The reduction of the material involves an electric process, and on this account it is not surprising that the manufacture of the metal centres at points where waterfalls afford a cheap supply of power. Modern developments of smelting have rendered available a metal of high purity, a good typical analysis being:—Al. 99.75 per cent.; Si. 0.15 per cent.; Fe. 0.10 per cent. It may be interesting here to recall some of the physical, mechanical and electrical properties of the metal, using the corresponding figures for copper for purposes of comparison:—

TABLE I.

	Aluminium.	Copper.
Atomic weight	27	63.2
Atomic volume	10.6	7.2
Position in Electro-chemical series	10	24
Melting point, deg. C.	625	1,060
Melting point, deg. Fahr.	1,150	1,940
Specific heat (water = 1)	0.212	0.094
Thermal conductivity (silver = 100)	31.3	73.6
Electric conductivity (silver = 100)	58.5	97.5
Coefficient of linear expansion per deg. C.	0.0000234	0.0000167
Coefficient of linear expansion per deg. F.	0.0000130	0.0000093
Specific gravity, cast	2.56	8.78
Specific gravity, rolled or drawn	2.71	8.95
Tensile strength in lbs. per sq. in.	20,000—30,000	40,000—60,000
Elastic limit as per cent. of tensile strength	60%	65%
Modulus of elasticity in lbs. per sq. in.	9,000,000	16,000,000

These figures, of course, refer to the pure metal and are perhaps somewhat wide of the founder's field. But they represent the properties of the base of the aluminium alloys and are therefore of some interest. Specific gravity and electrical properties particularly are affected by additions of other metals, the specific gravity being raised by most metals except magnesium that are alloyed with aluminium and the electrical conductivity lowered by addition of almost any metal. The physical properties, as in the case of all alloys, are affected according as the nature and quantities of the additions alter the constitution of the resulting alloy.

Alloys of Aluminium.

The commercial alloys of aluminium are now fairly numerous, and are likely to be more so as the knowledge of their properties extends. At present there is an element of uncertainty in the use of some of the metals which at first appear to give satisfaction when added to aluminium, and this tends to confine the field to copper and zinc for the great majority of purposes An example of the above-mentioned defect of unreliability is presented by the nickel-aluminium alloys; nickel has a similar influence to copper, but while 2 per cent. of Ni. gives an alloy which casts and rolls well, and possesses good physical properties, certain of the higher nickel alloys have been known to fall to powder in the atmosphere after a time.

The chief additions to aluminium include copper, zinc, manganese, nickel and tin. Other metals are also added in small quantities, in most cases to form ternary alloys with one of the above-mentioned metals. Aluminium alloys with every known metal, the union being generally accompanied by disengagement of heat. Most of the alloys are chemical combinations rather than mechanical mixtures, but lead and antimony are exceptions, and do not alloy very easily with aluminium. The influences and effects of different metals may be briefly summarised as follows:—

Copper.—This metal is added in quantities usually from 4 to 10 per cent., above which the alloy becomes brittle. For most purposes, in fact, 8 per cent. Cu. should not be exceeded, while Carpenter and Edwards claim that very little advantage is derived from adding more than 4 per cent. of Cu. The addition of 2 per cent. Cu. gives an alloy with a tensile strength of about 4 to 5 tons per sq. in. when sand-cast, and about 8 tons when chill-cast; 4 per cent. Cu. gives an alloy of 7 to 8 tons when sand-cast, and 9 to 10 tons when chill-cast; 6 per cent. Cu. gives an alloy of slightly higher tensile strength, while with 8 per cent. Cu. very little further increase is observable.

An alloy of Al. 92, Cu. 8, finds application for a variety of purposes. It is best made by adding the copper in the form of a "hardener" consisting of 50 Cu. and 50 Al., whereby overheating of the aluminium is avoided; the maximum temperature to which it should be raised being a blood-red heat. This alloy is very popular for hollow ware.

The practice of adding the copper in the form of a "hardening" alloy is a considerable factor in reducing metal losses. Since the copper melts at a much higher temperature than the aluminium, it must in any case be melted first. The aluminium is then added, combines with the copper and through chemical action the temperature is liable to rise to a point that vaporises much of the aluminium. The preparation of a rich alloy of half copper and half aluminium, cast into pigs for remelting, reduces this loss. The copper is melted first and the aluminium is added in small quantities, allowing the

temperature to gradually reduce with each addition of aluminium, thus preventing overheating any considerable quantity of metal. The "hardening" alloy melts at a much lower temperature than the copper, and hence is better suited for adding to the final aluminium mixture.

Copper-Manganese.—These two metals together form with aluminium an important series of alloys. The experiments conducted on behalf of the Alloys Research Committee of the Institution of Mechanical Engineers showed that about 3 per cent. Cu. and 1 per cent. Mn. gave excellent results. Cu. 2.89, Mn. 0.94 (balance Al.) as a sand casting, gave 7.48 tons per sq. in. ultimate stress, and 5 per cent. elongation. and as a chilled casting 12.05 tons ultimate stress and 13.5 per cent. elongation.

A somewhat more ductile alloy than the 92:8 Al.-Cu. is obtained with the composition:—Aluminium, 95.08 per cent.; copper, 2.34 per cent.; manganese, 1.78 per cent.; iron, 0.52 per cent.; and silicon, 0.28 per cent. To make this composition take 96 parts of aluminium by weight, two parts of copper by weight, and 2½ parts of ferro-manganese. Melt a portion of the aluminium, superheated to a temperature of approximately 950 deg. C., and add the ferro-manganese in granular form and the copper in small pieces. This mixture should be well stirred, after which the balance of the aluminium is added. This alloy has a high resistance to corrosion.

Manganese.—When added alone to aluminium, as little as 2 per cent of manganese destroys the ductility though adding somewhat to the strength. The compound formed with higher percentages of manganese is hard and brittle, and disintegration is liable to follow.

Zinc.—This metal is added to aluminium in amounts from 8 to 30 per cent., and is really the cheapest hardener commercially available. Up to 15 per cent. it increases the rigidity and strength of the metal. The addition of zinc facilitates the production of sound castings, but there is a tendency of the castings to crack in cooling, particularly if of a shape liable to that form of defect. This trouble, however, can be largely overcome by attention to design. Although it is often believed that these alloys are particularly weak under the action of vibratory stresses and of shock, the results of research work on the series do not confirm this. According to Rosenhain and Archbutt, the alloys richer in zinc, namely, those containing from 15 to 25 per cent. of zinc (with or without the addition of copper), are deserving of much closer attention, than the alloys containing less than 15 per cent. of zinc. The alloy containing 20 per cent. of zinc is the most generally useful of the simple binary alloys. Tensile tests on sand and chill-castings of a series of alloys covering the entire range of the binary system showed that the tensile strength of sand-castings steadily increases up to a concentration of 50 per cent. of zinc, when an ultimate stress of 18.7 tons per sq. in. is reached; there is then a slight fall of strength with further increase of zinc content, followed by a rise to a second maximum near 75 per cent. of zinc. As regards chill castings, three maxima were observed, the first at 30 per cent. of zinc with an ultimate stress of 17.9 tons per sq. in., the second at 50 per cent., with 21.6 tons per sq. in., and the third at 75 per cent. with 20.1 tons per sq. in.

The question of the possible "ageing," or even gradual spontaneous disintegration of the aluminium-zinc alloys was studied by these investigators in connection with the sand-cast material, tensile tests of some of the alloys being repeated on specimens which had been kept for over fifteen months, but no signs of any change were observed.

Magnesium.—This metal is a very valuable one in aluminium alloying, for it is a better deoxidiser than aluminium itself and also forms an alloy that is lighter than aluminium, the specific gravity of magnesium being only 1.7. Magnesium-aluminium alloys have long been known under the name of Magnalium, and have a high resistance to atmospheric influence. Usually, however, magnesium is used in small quantities (under 2 per cent.), and in conjunction with small quantities of copper, tin, nickel, or lead. Some of these alloys as cast have tensile strength up to 20 tons per sq. in.

A light but expensive alloy contains:—Al. 95.5 per cent.; Mg. 1.5 per cent.; Cu. 1.5 per cent.; and Ni. 1.5 per cent.

Nickel.—The influence of nickel is similar to that of copper, but when added alone the alloys of over 5 per cent. Ni. have a marked tendency to disintegration, falling to powder in the atmosphere. In most cases the amount of nickel used is less than 5 per cent., while 2 per cent. gives an alloy which casts well.

Sodium.—Sodium and all other alkaline impurities have a bad effect and are undesirable impurities in any alloy low in copper.

Chrome increases the hardness to such a degree that 50 per cent. chrome is sufficient to make a working of the aluminium an impossibility.

Silicon.—This element is readily taken up by aluminium in a molten condition in contact with a silicious material. When the amount of silicon absorbed in the metal is over 2 per cent. the colour is impaired, and the metal becomes less malleable. The effect of silicon is to harden the metal, but it has been stated that up to 5 per cent. may be present without damaging it for use in castings.

Tungsten has the effect of hardening aluminium and has been recommended by some writers, but its use is of doubtful advantage.

There are also other of the rarer metals which have given rather remarkable results in aluminium alloying, but these are somewhat outside the scope of the general founder.

Tin in small quantities renders aluminium fragile, 3 per cent. giving a brittle alloy; but in larger quantities this does not appear to be the case. At the present price of tin, however, it does not appear to be practicable addition to aluminium, since it does not materially increase the strength of the metal.

An alloy which is claimed to be non-corrosive and suitable for the production of the metal parts of mining machinery, or as a coating for such castings, was patented by Gaston Jacquier, South Africa, in 1912. The alloy consists of aluminium, bismuth, copper, silicon and magnesium, and either of the following mixtures can be used:—Aluminium, 92 per cent.; bismuth, 2 per cent.; silicon, 1 per cent., and copper, 5 per cent.; or, aluminium, 91 per cent.; bismuth, 2 per cent.; magnesium, 2 per cent.; and copper, 5 per cent.

Fluxes.

The chief difficulty in dealing with the oxides which form on molten aluminium lies in the fact that there is little difference in the specific gravity of the oxide and that of the metal itself. On this account the oxide remains entangled in the metal itself and forms a thick, pasty mass, and it is then quite impossible to skim off the dross without wasting a considerable amount of metal. A number of fluxes have at different times been employed to overcome this trouble, but many have met with ill success. If charcoal, for instance, is used it is very difficult to skim off and it is apt to get into the mould. Salt is to a certain extent efficacious, but

does not readily melt, though it is used in a good many foundries. Chloride of zinc gives good results, particularly with alloys containing zinc, and is added, after the metal has been removed from the fire and cooled to the desired temperature, by being thrown on the surface of the metal in the crucible.

Chloride of zinc is made by dissolving metallic zinc in muriatic acid, but the founder is better advised to purchase it in the white lump form. If, however, it is desired to make the chloride of zinc, the procedure is to dissolve (in the open air) all of the zinc that will be taken up in strong muriatic acid. A vessel of stoneware is necessary for holding the acid (glass will answer but is apt to crack by the heat generated), and when all the zinc is dissolved that the acid will take up, the liquid is placed in an enamelled-iron pan and evaporated to dryness over a fire. Some undissolved zinc should remain in the bottom to make sure that all the acid has been taken up. In this manner the chloride of zinc is obtained in the form of lumps, which should be stored in air-tight receptacles, as it readily absorbs moisture and becomes soft and finally liquid.

The chloride of zinc flux should in ordinary circumstances not be added while the crucible is in the furnace (unless just before removal, and when the furnace is near the moulds). The metal should be melted in the usual manner and any gates or scrap added, and when at the desired temperature the chloride of zinc should be thrown on the surface of the metal. A piece the size of a good-sized walnut is sufficient for an ordinary pot and is preferably added in small portions at a time. Considerable smoke is given off when the flux is added, and the metal should be vigorously stirred. When all has been added the surface of the aluminium should be found quite clean and covered with a dry, fine powder which may be readily skimmed off, leaving the clean metal beneath. As stated, the flux should not be added until the aluminium is ready for pouring, but on account of the fumes given off it may be added just before removing the pot from the fire so that they will be drawn up the flue and carried away. It is easier, however, to add it when the pot is on the floor, and in the case of tilting furnaces and hand ladles this is, of course, necessary. Since the quantity to be used will depend upon the amount of dross on the surface of the metal, if the metal is not cleaned by the first lump of chloride of zinc more should be added.

One writer states that chloride of zinc can be prepared conveniently from the white oxide that adheres to the crucibles used for melting yellow brass. This material is collected and when required for fluxing aluminium a couple of ounces can be placed on a piece of paper and made slightly wet with muriatic acid, after which it is thrown on to the surface of the molten metal and allowed to dry before being stirred in.

It may be mentioned that the chloride of zinc should be handled by means of tongs, as the chemical attacks the skin of the hand and gradually cracks it. The volume of fumes which rises ceases in a short time, and exposes the metal surface. After the addition of the zinc chloride there is a slight boiling of the metal surface due to the reaction of the metal and chemical. The zinc chloride becomes black and flows towards the edges of the crucible. The oxide takes the form of powder, and can be skimmed off without any trouble, so that the metal finally, when ready for pouring, has a pure, bright surface.

Other fluxes that are used include common salt, and pottasium nitrate or saltpetre. The latter should be pulverised, and two or three ounces used to a large crucible. When dealing with the dross from scrap, the dross should be at a read heat or the reaction will not occur, and unless it does, the flux is valueless. The reaction is rather violent, and as soon as it commences the cover should be placed over the furnace.

Tests made by H. M. Lane to determine the effect of additions of magnesium to cast aluminium (99 per cent. pure) were presented before the American Institute of Metals in 1911. The metal was remelted several times, and 0.5 per cent. of Mg. added at the first melt, and also at each remelting. A corresponding series was also tried without the magnesium additions. Four bars of about 0.5 in. diameter (0.2 sq. in.) from each cast were made and tested without machining. The results are summarised in the following table, A-1 to A-9 representing the metal with magnesium additions. In the case of the eighth melting the metal was not hot enough to run perfect bars, and so it was weighed and returned to the pot and the ninth melting made, so that between the A-7 and A-9 meltings 1 per cent. of magnesium was added. Beginning with the ninth cast of the B series, 0.5 per cent. of magnesium was added and this was repeated for the remaining remelts.

TABLE II.—*Effect of Magnesium in Aluminium cast in Sand.*

Mark	Elastic limit	Ultimate tensile strength	Elongation in 4 in.	Elongation in per cent.	Reduction in area.	Mg. left in metal.	Remarks.
	Lbs. per sq. in.	Lbs. per sq. in.			Per cent.		
A-1	8,630	15,970	0.44	11.0	7.5	0.66	Coarse granular fracture.
A-2	9,300	15 960	0.14	3.5	2.9	0.87	
A-3	10,530	17,670	0.23	5.75	0.2	1.32	
A-4	9,610	16,320	0.20	5.00	3.1	1.74	Break at fillet-partly crystallised.
A-5	9,430	17,010	0.17	4.25	5.0	2.43	" "
A-6	8,950	16,550	0.15	3.75	—	2.43	" "
A-7	11,130	23,330	0.31	7.75	5.7	2.56	Blue-grey,finer structure at break
A-8	—	—	—	—	—	—	
A-9	12,470	24,320	0.28	7.00	11.8	3.74	" "
B-1	5,810	10,730	0.48	12.0	24.7	—	
B-2	5,680	11,990	0.85	21.25	37.8	—	Slight flaw.
B-3	5,340	11,140	0.48	12.00	13.8	—	
B-4	6,100	13,040	0.65	16.25	20.3	—	Break in fillet.
B-5	4,850	12,900	0.77	19.25	32.9	—	
B-6	4,545	13,030	0.87	21.75	40.2	—	
B-7	4,620	12,540	0.86	21.5	41.1	—	
B-8	5,040	12,560	0.94	23.5	27.7	—	
B-9	8,540	16,170	0.35	8.75	14.8	0.86	
B-10	8,950	18,360	0.34	8.5	8.2	0.85	
B-11	9,350	16,930	0.20	5.00	4.4	1.39	
B-12	9,430	18,920	0.28	7.0	9.4	1.75	
B-13	8,550	18,630	0.26	6.5	5.5	2.32	
B-14	9,000	18,650	0.28	7.00	5.2	2.41	
B-15	10,870	20,350	0.28	7.00	3.5	2.64	
B-16	10,960	19,950	0.18	4.5	6.6	2.69	

The increase in the tensile strength with the increase in magnesium left in the metal (shown in the seventh column of the table (is noteworthy, but since a small amount of chloride of zinc was, in accordance with the melter's regular practice, placed on the metal when it became molten, it is difficult to say whether the benefit resulted from the magnesium as a deoxidiser or as an alloying element. The latter would be suggested by the fact that the remelting without magnesium did not decrease the strength, but rather the reverse. These experiments indicate that for pure aluminium chloride of zinc is an effective dioxidiser, the rise in strength and ductility of the B series probably resulting from the fact that in B1 there was found 0.015 per cent. of zinc, and in B8 it was found that 0.085 per cent. zinc had apparently passed into the metal from the chloride-of-zinc flux.

Deterioration of Alloys.

As previously mentioned, the high nickel alloys are liable to deterioration by a chemical or electrolytic action. The manganese-aluminium alloys are similarly subject to disintegration, and certain of them fall to powder in the atmosphere.

Another alloy which was found to disintegrate under atmospheric influence was composed of copper 2 per cent., tungsten 0.5 per cent., and aluminium 97.5 per cent.

Furnaces

Aluminium, like other non-ferrous metals, can be melted in any class of furnace which provides the necessary heat and affords protection from the effects of the fuel and gases. The ordinary draw-out pit-type of crucible furnace is used by some, but the writer recommends rather the tilting furnace, oil, gas or coke fired, according to circumstances. Of course, where only small and intermittent quantities of the light alloys are being handled by a brass founder it may be found more convenient to use the draw-out crucible type, reserving pots for that work only. The tilting crucible furnace, however, affords various advantages in cases where larger quantities are being handled regularly. The open-flame reverberatory furnace has been employed for the aluminium alloys, but is not to be recommended. In one American foundry using this form of furnace the heavy loss of nearly 7 per cent. was experienced in melting, but on the adoption of the tilting crucible type, similar to the regular non-ferrous foundry type but with an iron kettle of the proper size and shape in place of the crucible, the loss was reduced to 2½ per cent. Since in the iron kettle the flame did not touch the metal at all, the time of the first heat was longer, but that was not found to materially affect the total output. Another great advantage in the kettle type of furnace is that the slag and oxide which form on the top of the pot act as a protection to the metal and the spatter, skimmings, etc., instead of being thrown onto the scrap pile, are returned to the melting pot, where the globules of metal held in suspension in the slag separate from the slag and mix with the metal below, the slag itself remaining on top in the form of a protecting covering.

Melting and Pouring.

The first essential in dealing with aluminium alloys is to avoid over-heating. The metal should be melted fairly rapidly, but the foregoing requirement necessitates considerable care and unless the melter knows his furnace well and can regulate it nicely it is safer to err on the side of slow melting than to risk over-heating. As a general principle, when mixing the metals in the crucible, the metal with the highest melting point should be run down first and the others added afterwards.

Since, as a rule, no protective covering of charcoal is used in melting, the metal is more or less exposed to the atmosphere and liable to absorb nitrogen, this absorption increasing the higher the temperature. For this reason also the temperature should not be raised above that necessary. Oxidation also occurs excessively through over-heating, and gas bubbles are formed in the castings. The melting should therefore be at such a rate that no part gets over-heated before the rest of the metal is melted, and the ultimate temperature should only be sufficiently above pouring heat to allow for the loss through handling in the ladles, etc. Nor should it be allowed to soak in the furnace. The ladles or dippers should be heated so as to avoid unnecessary loss of heat, which otherwise would have to be compensated for by a higher temperature of metal as it comes from the furnace. Thorough stirring of the metal and careful skimming are advisable before dipping or pouring.

Casting Temperature.

Not only must the danger of overheating the alloy during melting be guarded against, but the pouring temperature of the metal must be carefully observed. Naturally the pouring temperature will vary with the different mixtures, but careful observation will enable the founder to judge approximately the best temperature for any particular alloy which he is frequently using. As a general rule the pouring heat should be as low as practicable and consistent with properly filling the mould and obtaining sharp definition in the casting. Since, also, the metal chills very rapidly, the pouring must be correspondingly rapid, and the runners and risers must be arranged to this end.

Crucibles.

While some founders claim that for aluminium only new graphite crucibles, or those that have been used solely for aluminium, should be employed, others advise a crucible that has served for a couple of heats of copper or bronze, since these have been toughened by a temperature higher than obtained in melting aluminium. If it is desired to use a pot which has not been contaminated by any other metal, it is advisable to thoroughly heat it first, as otherwise it is liable to severe wear near the top where the furnace tools come into contact with it. The cold material should be added before the first charge has completely melted, in order that it may become heated before descending into the molten metal. This should be continued until the pot is full. If, however, the metal is all molten, no more cold metal should be added than the metal will dissolve. Otherwise, it will freeze and when it commences to remelt will expand and break the crucible. The strained crucible does not always leak at the time the damage is done, but may run a couple of heats before it gives out. Also, no buttons should be left in the crucibles. When melting aluminium alloys in graphite crucibles, it is highly desirable to avoid scraping the crucible during stirring, as this tends to cause a combination of the carbon with the metal, resulting in black spots in the metal ultimately. With ordinary treatment the carbon will not combine with aluminium at the proper melting temperature of the metal.

Moulding.

With the more extensive use of aluminium alloys in foundry work, it is found that the methods of moulding available are fairly wide, providing the essentials are observed. Green-sand moulds are usually employed, as they allow of some shrinkage of the metal. The chief necessity is to avoid ramming the moulds too hard, for it is the hardness of the dry-sand mould that rules it out for aluminium work, owing to its liability to give a cracked casting with a design that would be all right in the softer green-sand mould.

It need not be impressed on moulders that the light ramming which is desirable in moulds for aluminium castings necessitates great care being taken to avoid drop-outs. It is scarcely necessary to instruct an intelligent moulder on the requirements further than to say that he must consider just the necessity of

getting a light, soft mould that will hang together sufficiently to take the metal.

Where possible, the use of several gates and risers is recommended with castings of any considerable size or weight. These allow the metal in a properly molten condition to get to every part of the mould, and should be rather large than small. It is customary in some shops to chill the risers and gates after the mould is completely filled, by placing pieces of aluminium in them, the risers and gates being then broken off to allow the dumping of the casting to be freely done. The risers on heavy parts should be sufficiently large to properly feed the casting, as small risers often do more harm than good, by setting up shrinkage stresses by reason of cooling before other parts.

The sand for aluminium work may be finer than for brass and bronze, as the amount of gases given off in pouring is not very great. Nevertheless, the mould should not be too dense. Since the temperature of the metal is low compared with that of the copper alloys, the sand does not need to be so refractory, provided it is free from any undue amount of organic matter. The face of the mould should be treated with black-lead, French chalk, or petroleum and lycopodium powder.

Cores.

The importance of suitable cores can scarcely be over-estimated, particularly when using the zinc-aluminium alloys. When possible, green-sand-cores are advisable, and where baked cores are required they should be made as soft and yielding as possible to accommodate the shrinkage. Old burnt sand wet with molasses water has been found to give good results, but there are various other binders which if properly used serve equally well. The essentials are a fairly open-sand that will give a clean face without being so hard as to withstand the pressure of the metal in cooling, and sufficient binder to keep it up while the metal is being poured. Coating with a core-wash is generally conceded to be a mistake, as it closes the pores of the core and prevents the escape of the gases; neither is there the slightest necessity for it, on account of the low heat at which the metal is poured. It must always be borne in mind that if the metal in shrinking cannot crush the core, internal strains which will ultimately result in cracks are almost sure to occur.

In one American motor-car factory's foundry, crank cases and similar castings are moulded with green-sand cores. Machines are employed for moulding and aluminium flasks are used. Aluminium plates take the place of bottom boards, and these, with the green-sand cores, form the bottom part. The core box is rammed by hand on the machine, and after the aluminium plate is bedded on, it is rolled over on the machine and the core box is lifted off.

Dense Moulds and Cores.

In order to equalise the rates of cooling in irregular designs of castings, denseners or "chillers" of iron, brass or aluminium can be employed, the latter metal having the advantage of lightness. The size and thickness will be regulated by the thickness of that part of the casting concerned and the acceleration for cooling required. The application of denseners in aluminium work is based on exactly the same principle as involved in their use in ironfounding, viz., the hastening of the rate of cooling in thick parts to prevent stresses being set up by unequal cooling. The separation of carbon is, of course, not involved in the case of aluminium alloys, but the crystallisation is affected and made finer by the use of denseners.

Foundries of the Manganese Bronze and Brass Company, Limited.

The members of the Institute of Marine Engineers on Saturday, July 4, visited the foundries of the Manganese Bronze and Brass Company, Limited, Millwall, E. The Company was formed in the year 1882 by the late Mr. Percival M. Parsons, for the manufacture of the various alloys with which his name is associated. As early as 1878 Mr. Parsons produced the first high-tension bronze which became known as "Parsons' manganese bronze," and which he introduced principally for the purpose of replacing iron and steel for steamship propellers. The alloy presented a notable resistance to corrosion, and at the same time eliminated the heavy expense entailed by the continual replacement of iron and steel propellers.

The Company's works to-day for the production of high-tension bronze propellers of all types and sizes are claimed to be the best equipped in the world, both in the matter of their capacity for the production of propellers of the largest diameter and weight, and the special machinery which the Company have produced and erected for finishing the propellers required for the turbines of such liners as the "Aquitania," "Imperator," "Mauretania," "Lusitania," and "Olympic." The finished propellers for vessels of this class weigh approximately 20 tons each, which means that about 30 tons of bronze has to be melted to produce the castings. These propellers have to be so accurately finished and balanced that they can be turned by pressure of the hand when suspended on a mandrel, and it is therefore obvious that technical knowledge and experience in bronze founding must be accompanied by high-class machinery and apparatus.

In the foundry there are five large pits for the purpose of moulding and casting propellers of the type referred to and, in addition, a number of other pits for the production of single blades used with built-up propellers of all classes. In a side bay are all the mould ovens. The plant includes a series of electrically-driven overhead cranes which enable the ladles containing the molten metal to be carried from the furnace to the casting pits with the greatest facility.

The advent of the turbine obliged the Company to enter into a new field of research, with the object of finding an alloy which would present the maximum resistance to erosion. A very comprehensive investigation of the subject, extending over a period of three or four years, finally enabled the Company, with the assistance of their chemist, Dr. O. Silberrad, to produce an alloy to withstand the onerous conditions to which the propellers of high-speed turbine-driven vessels of all types are subjected.

In the various shops, machines of all types for trimming and finishing the propellers and other castings were inspected. Amongst these, interest was centred in a special machine for trueing propellers to the exact drawing pitch, and other apparatus for finishing and balancing, facing, boring, recessing, etc., all types of propellers and blades from the smallest to the largest diameters. Many of these machines have been specially designed and constructed by the Company in their own works, and are quite unique in their features.

In a separate foundry various descriptions of general castings were shown in course of construction. The rolling mills, the forge and the stamping machinery are at the St. George's Wharf Works of the Company, on the other side of the river.

L

International Specifications.

Proposals have been presented to the Council of the International Association for Testing Materials for standard specifications for pig-iron, for cast-iron pipe, and for an international test bar for judging the quality of the metal entering into iron castings. These proposals are confined to the world's export trade.

The Cast-Iron Committee.

Last year preparations were made by the American members of the Committee on Cast Iron to visit Europe and to push the matter as energetically as possible. A Committee meeting in Brussels on December 5, 1913, brought about definite proposals for pig-iron, cast pipe, and an international test bar. The proposals were originally drawn up on American lines, modified by the German members to suit the Continent, with co-operation from Belgium and France, and support was given by some British producers. With the exception of the test bar, however, the English members would not adopt the work thus prepared, but submitted a minority report to the Council of the International Association.

A sub-committee on the preparation of standard methods of sampling and analysis for cast iron was authorised. The members for England are Messrs. J. E. Stead and F. W. Harbord; for Germany, the Krupp Laboratories; and for the United States, Dr. Hillebrand of the U.S. Bureau of Standards.

An International Test Bar.

Appended is the resolution on the subject of an international standard cast-iron test bar adopted at the meeting of Committee 1 (b) at Brussels, December 5, 1913 :—

(1) In order to obtain a reasonable uniform test bar (arbitration bar) for judging the qualities of iron poured into castings, with reference to existing systems of measurement, a bar shall be selected for testing transversely on supports 18 in. apart (45 cm.) and that the diameter of this round bar shall be 1.2 in. (30 mm.), the relation of length to diameter being 15 to 1 as nearly as may be.

(2) The bars shall be cast in dry-sand moulds, vertically and with top pour. They shall be cast 20 in. (50 cm.) long, and be rounded at the bottom. The load in testing shall not be applied faster than three seconds for every hundredth part of the diameter. For every specification mixture two moulds with three test bars each shall be cast, the bars to be cold before removal from the moulds which should have attained the shop temperature before pouring. The bars shall be brushed clean and not rumbled.

International Export Specifications for Pig-iron.

At the meeting of Committee 1 (b) at Brussels, as referred to above, the following was adopted for recommendation to the Council of the International Association :—

(1) It is proposed that for international trading purposes in pig-iron, the analysis be taken as the basis, inasmuch as the value depends upon its content.

(2) The following specifications for pig-iron are recommended where the customary trade designations are insufficient (see tables below). For silicon a variation of 0.25 per cent. from analysis asked for, either way, shall be allowable. For sulphur and phosphorus the maxima given shall govern. For manganese a variation of 0.20 per cent. either way shall be allowable.

Silicon.

Per cent.	Code
0.50	La
0.75	LaX
1.00	Le
1.25	LeX
1.50	Li
1.75	LiX
2.00	Lo
2.25	LoX
2.50	Lu
2.75	LuX
3.00	Ly
3.25	LyX
3.50	Lh
3.75	LhX

Variation 0.25 either way allowable.

Sulphur.

Per cent.	Code.
0.02	Sa
0.03	Se
0.04	Si
0.05	So
0.06	Su
0.07	Sy
0.08	Sh

(Maximum)

Phosphorus.

Per cent.	Code.
0.050	P
0.100	Pa
0.250	Pe
0.500	Pi
0.750	Po
1.000	Pu
1.500	Py
2.000	Ph

(Maximum)

Manganese.

Per cent.	Code.
0.20	Ma
0.40	Me
0.60	Mi
0.80	Mo
1.00	Mu
1.25	My
1.50	Mh

Variation 0.20 either way allowable.

It was resolved that the code words above given are to be specially recommended as most useful for international commerce in pig-iron.

The English members of Committee 1 (b), while concurring in the specifications for cast-iron test bars, did not accept the above pig-iron specifications, but instead suggested the following :—

Grade.	Silicon, per cent.	Sulphur, Max. per cent.	Phosphorus, Max. per cent.	Manganese, per cent.
1	2.5 to 3.5	0.05	1.750	0.40 to 1.00
2	2.0 to 3.0	0.08	1.750	0.40 to 1.00
3	1.5 to 2.5	0.12	1.750	0.40 to 1.00

Committee 1 (b) also recommended international specifications for cast-iron pipes and fittings. From this the English members also dissented.

Discussions before the American Society.

At the seventeenth annual meeting of the American Society for Testing Materials, on June 30 to July 3, a large number of Papers and committee reports were considered.

Sulphur in Cast Iron.—Cast iron took up a large part of the session on Wednesday evening, which was presided over by Dr. Richard Moldenke, who presented the report of the Committee A-3 on standard specifications for cast-iron and finished castings. He stated that the work of the Committee the past year had been devoted to the revision of two of the standard specifications originally issued, those for locomotive cylinders and for malleable castings. He called attention to the increasing use of scrap in making grey-iron castings which had resulted in raising the sulphur content due to constant melting of this material. The time was coming, he thought, when the sulphur limit will either have to be raised or this item be struck out altogether. It was increasingly difficult to adhere to specifications, and a method of desulphurising cast iron would be welcome.

As to specifications for malleable castings, Dr. Moldenke stated that the Committee had not completed its revised specifications. The conditions to be met had changed considerably in recent years in the malleable business, in that large castings were

now made in steel that used to be made in malleable cast iron. Because of this the tendency in foundries was to operate for light casting work only, necessitating all the more attention in the revision of the standard specifications, particularly in railroad work. For this reason the duly prepared specifications for malleable castings were still in the hands of the Sub-Committee for further consideration.

Cast-iron Test Bars.—Some interesting remarks were offered on the subject of the cast-iron test bar; the method of pouring this, as laid down in the proposed international specifications, calling for a top pour.

Dr. L. Waldo said he did not consider that top pouring produced as homogeneous a bar as bottom pouring.

Dr. Moldenke replied to this that if test bars were poured flat and then tested, a difference of 200 lbs. in strength was found between the top and the bottom of each side. Similar non-homogeneity resulted from bottom pouring.

Mr. Thomas D. West favoured top pouring entirely even for large castings, while Mr. Walter Wood remarked that 95 per cent. of all cast-iron pipe, 13 to 14 ft. long, was top poured. Mr. S. V. Hunnings (American Locomotive Company) remarked that his company were successfully top-pouring thousands of bars a year.

Mr. J. E. Johnson, Junr., in regard to cast-iron specifications in general, said that he felt it was a pity that they were usually so indefinite, and that much that had been found out did not appear in them. He thought some account of these accomplishments ought to be taken. He did not think that the question of fracture should be entirely ignored, for much could be told by it, and all dependence should not be placed on analysis, for irons of the same ordinary analysis often differed in fracture and also decidedly in strength.

American Foundrymen's Convention.

The annual meeting of the American Foundrymen's Association, and simultaneously the annual meetings of the American Institute of Metals, and the Associated Foundry Foremen, will be held on September 7 to 11 next, at Chicago. This annual convention of the Associations in question will, as usual, be accompanied by a display of foundry equipment and supplies. Joint sessions will also be held to consider various Papers applicable to such meetings, while other Papers will be presented at separate sessions.

The provisional programme of the American Foundrymen's Association is as follows :—

Monday, September 7.—Registration at La Salle Hotel.

Tuesday, September 8.—Morning: Joint meeting with the American Institute of Metals and Associated Foundry Foremen; Papers on "Safety Work in Foundry Oeprations." Afternoon: Individual session; Papers on "Foundry Construction and Equipment."

Wednesday, September 9.—Morning: Joint meeting with the American Institute of Metals for a "Cost Congress," when Papers will be read and addresses delivered on the necessity of obtaining accurate costs in foundry operations. How to tender for work will be discussed, and a report on this subject will be submitted. The Cost Committee of the American Foundrymen's Association will present its annual report, suggesting a revision of the Standard Foundry Cost System and a number of Papers will be read on " "Efficiency in Foundry Operations." Afternoon: Discussion on "Malleable Foundry Practice," followed by a stockyards inspection. Evening: Visit to the White City.

Thursday, September 10.—Morning: Discussion on "Steel Foundry Practice." Afternoon: Discussion on "Grey-Iron Foundry Practice." Evening: Banquet at the La Salle Hotel, for members only, and also a banquet for the ladies at the La Salle Hotel.

The provisional programme of the American Institute of Metals is as follows :—

Monday.—Registration. Evening: Foremen's banquet at La Salle Hotel.

Tuesday.—Morning: Joint meeting with the American Foundrymen's Association. Afternoon: Reports and discussions on Papers.

Wednesday.—Morning: Joint meeting with A.F.A. as above, followed by stockyards inspection.

Thursday.—Morning: Papers and discussions. Afternoon: Papers and discussions and election of officers. Evening: Banquet at La Salle Hotel, for members only.

Friday.—Morning: Last Session.

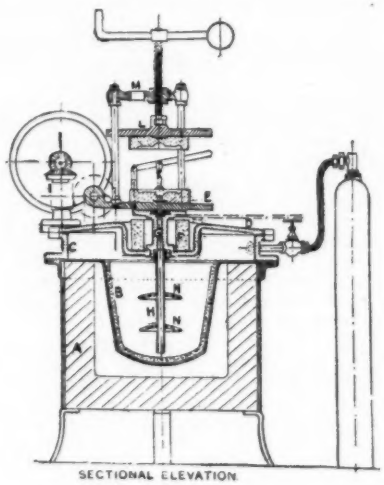
THE SWEDISH PIG-IRON INDUSTRY SINCE 1900.—In a contribution to a recently-published Swedish work, Mr. Gunnar Dillner points out of what immense importance the magnetic separating and briquetting processes have been to the Swedish iron industry, as they have rendered possible the utilisation of enormous quantities of ore, and contributed to reducing the consumption of charcoal, which has been constantly rising in price since 1900. The Gröndahl processes are employed in mines comprising an ore area representing about 24 per cent. of the total in Southern and Central Sweden. The production of "slig" amounted in 1912 to 521,000 tons, of which quantity 175,000 tons were exported, while the remaining 351,000 tons were consumed at home. By the employment of slig it has become possible to increase the iron content of the blast furnaces charges, with a reduction of charcoal per ton of pig-iron, and the use of briquettes has also had the same effect on account of their being more easily reduced, while the average capacity of the blast furnaces per 24 hours has been raised by from 14 to 20 per cent. during the years under review. As to electrical smelting, enquiries have shown that large supplies of energy can scarcely be obtained at prices which will allow competition with blast furnaces in Central Sweden, except in the Dal River and the Klara River districts. The supplies of electrical energy as well as of charcoal are very much dependent on the Northern part of the country, and as far as electrical smelting is concerned the development of this industry will very soon be almost entirely associated with Norrland, The manufacture of pig-iron for export mignt possibly be removed with advantage to Norrland, as the sale of pig-iron for export is increasing rapidly, amounting now to about 200,000 tons, as compared with 87,000 tons in 1904, when the Gröndahl processes came into use. The works engaged in this business have already disposed of the main portion of their outputs for 1914, and some have even made contracts for the whole of their production for two years to come, and the stocks are sold out altogether. Some authorities view the idea of forming an export combine with approval. An attempt in this direction was made some years ago, when the A/B Jern Export was formed.

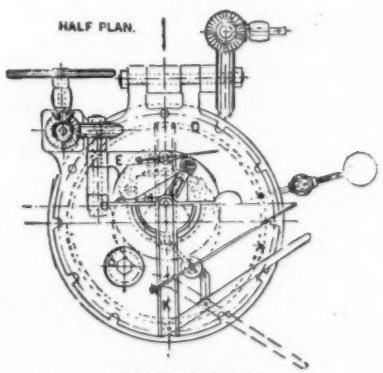
A New Die Casting Apparatus.

A new automatic die casting machine has just been perfected by National Alloys, Limited, Ilford, London, E., with the object of die casting light aluminium alloys, of specific gravity of 2.85. It is also adapted for die casting other non-ferrous alloys such as Babbitt's metal, zinc alloys, etc. The apparatus, known as the "Alitor," is shown in the accompanydiagrams.

A furnace with the necessary crucible to contain the molten metal forms the base of the machine. Bolted to this is a neck piece on top of which is fixed a domed cover, near the centre of which is formed a pocket having screwed into it a circular block of specially hard metal, bored out to form a taper nozzle and slotted to take the sprue-cutting bar. In this socket and around the taper nozzle is a small furnace which keeps the metal perfectly molten, right up to the time of entering the die. Held in place by means of a gland and stuffing-box on the underside of the nozzle is a tube of refractory material which passes down through the molten metal to within about half an inch from the botom of the crucible. Through a gland in the domed cover a spindle runs down into the crucible carrying two perforated discs, which are plunged up and down in the molten metal by means of a hand lever, thus keeping the metal well agitated. A hole with cover is also placed in the domed cover to allow of the crucible being filled without removing the cover. Hinged to the domed cover is a plate to which is fixed the bottom half of the die to be cast from, and having in the centre a hole to register exactly with the before-mentioned nozzle in the circular block of hard metal, and also with the filling hole in the bottom half of the die. The hinged plate referred to is tilted back into any desired position by means of a suitable bevel-and-worm gear. Screwed into the hinged plate are three bright mild-steel pillars carrying a bridge piece, through the centre of which works a double-threaded quick-running screw, operated by a heavy hand-wheel or crossbar at the top and carrying at the other end a plate registering on the three pillars referred to. This plate carries the top half of the die. The domed cover together with the centre tube, agitating discs and all the top gear is capable of being thrown back by means of a worm gear, thus allowing the crucible to be readily got at.

The metal to be melted is placed in the crucible through the filling hole, and the furnace is lighted. The bottom half of the die is fixed to the hinged plate and the top half to the plate carried by the quick-running screw. This is now run down so that the top and bottom halves of the die are brought tightly together. When it is necessary to use a multiple-part die, a convenient detachable arrangement is provided to work horizontally in conjunction with the vertical clamping arrangement mentioned. The sprue cannot pass through the nozzle, and the hinged plate is clamped down. Connected to the neck-piece is a cylinder of liquified gas, the valve controlling which is now opened allowing the gas to exert pressure on the top of the molten metal in the crucible. The sprue-cutting bar is now pulled back, thereby allowing the metal to be forced up into the die. The die being full, the sprue-cutting bar is pulled back again, thereby stopping any further flow of metal, the hinged plate is unclamped and the whole of the top gear thrown back by means of the bevel-and-worm gear, on to a table: the top half of die is now pulled up by means of the screw and the casting is automatically knocked out by means of three rods carried on bridge piece and which run into the top half of the die nearly down to the casting when the two halves of the die are together. The whole top gear is now thrown back, the hinged plate is clamped down, the two halves of the die brought together again, and the sprue-cutting bar (out of which the small piece of metal, cut away, has been punched by means of a lever punch carried on hinged plate) is again put into position to allow the metal to flow into the die, and the process is continuously carried on as before described.





A.	Furnace.	H	Refractiery Tube
B.	Crucible.	K	Sprue Cutting Bar
C	C.I. Neck Piece	L	Top Die Plate
D.	Domed Cover	M	Bridge Piece
E.	Bottom Die Plate	N	Mixing Discs
F.	Small Furnace	O	Filling Hole
G.	Hard Metal Nozzle.		

"ALITOR" DIE CASTING MACHINE.

Great pressure can be exerted on the molten metal, as when the liquified gas is brought into contact with a hot substance the expansion is such that at a temperature of only 45 deg. C., a pressure of 100 atmospheres is obtained and proportionately higher pressures can be maintained according to the various temperatures worked at. The gas used is an inert one, and therefore has no action on the metal, and is not absorbed by it.

Trade Talk.

THE firm of Messrs. Hollingdrake & Son, Limited, ironfounders, of Stockport, has just celebrated its centenary.

MR. H. BATH SPENCER has established himself in business at Winchester House, Birmingham, as an inspecting engineer and export agent.

MESSRS. BURYS & COMPANY, LIMITED, Regent Works, Shemeld, makers of crucible steel, forgings, castings, etc., have opened a new foundry erected on modern lines.

THE works of Messrs. Leech, Goodall & Company, engineers, of Hunslet, Leeds, were closed on Friday, July 31, for the annual holidays. Operations will be resumed on August 11.

MESSRS. JAMES TURNBULL & COMPANY, 3, New Street, Birmingham, have been appointed sole agents in Great Britain and Ireland for the Hohenzollern Locomotive Works, of Düsseldorf.

MESSRS. J. G. & H. ABRAHAMS, 306, Mansion House Chambers, London, E.C., have been appointed British agents for Heinr. Aug. Schulte Eisenhandlung A.G., Dortmund, Germany.

MR. H. G. HUMBY, recently consulting engineer to the South African Government, has established himself in business as railway consulting engineer, etc., at 20, Victoria Street, London, S.W.

MORRIS & LISTER (LONDON), LIMITED, 3 & 4, Palace Chambers, Bridge Street, Westminster, S.W., have been appointed agents for London and the South of England for Mickelwright, Limited, Alperton.

MESSRS. F. HOLMES and P. WALMSLEY, carrying on business as engineers and tool makers, at Neill Street, Armley Road, Leeds, under the style of the Leeds Vise Company, have dissolved partnership.

MESSRS. J. W. TAYLOR, A. W. TAYLOR, S. TAYLOR, and D. TAYLOR, carrying on business as engineers, at Marshall Mill, Portland Street, Bradford, under the style of John Taylor, have dissolved partnership.

MESSRS. F. A. GRAINGER and J. B. HARGREAVES, carrying on business as engineers and steel and general agents, at 1, Basinghall Square, Basinghall Street, Leeds, under the style of Grainger & Hargreaves, have dissolved partnership.

IN the Companies Winding-up Court on July 28, before Mr. Justice Astbury, a petition was heard for a compulsory order to wind up Tannett Walker & Company, Limited. His Lordship directed the petition to stand over till the first petition day of next sittings.

THE BRITISH THOMSON-HOUSTON COMPANY have had two additional lines installed in their private telephone exchange at Mazda House, 77, Upper Thames Street, London, E.C. The telephone number has also been changed, and in future will be Central 10434 to 10438.

G. P. WINCOTT, LIMITED, of Attercliffe Road, Sheffield, have secured an order from the Grovesend Steel and Tinplate Company, Limited, of Gorseinon, for one 35-ton basic steel melting furnace, three 10-cwt. gas producers, and one 27-in. double beat gas reversing valve.

THE STANTON IRONWORKS COMPANY, LIMITED, have been summoned under four charges of infringing the provisions of the Factory and Workshops Acts, 1901 to 1911, by employing four boys on May 27 during prohibited hours. The Ilkeston Bench imposed the minimum penalty of £1 and 15s. costs on each charge.

THE co-partnery of Ross and Duncan, engineers, boilermakers, and shipbuilders, Whitefield Works, Govan, has been dissolved by the retirement of Mr. Robert Rankin. The business will be continued by Messrs. R. Duncan, A. E. Lonergan, J. Gloag, J. A. Rankin and R. Duncan, junr.

MR. G. G. POPPLETON, of 26, Corporation Street, Birmingham, has been appointed liquidator of Thornewill & Warham, Limited, to act jointly with Mr. J. E. Pritchard, King's Court, Colmore Row, Birmingham, the liquidator appointed by the creditors of the company.

THE partnership heretofore subsisting between Messrs. E. Waddington and J. B. Waddington, carrying on business as engineers and iron founders, in Barrow-in-Furness, under the style of Joseph Waddington and Sons, has been dissolved. Mr. E. Waddington will continue the business.

THE partnership heretofore subsisting between Messrs. J. Woodward and W. J. Modley, carrying on business as marine and general engineers, at Plymouth, under the style of J. Woodward & Company, has been dissolved. The business will be continued by Mr. J. Woodward.

THE partnership heretofore subsisting between Messrs. J. W. L. Hepton and A. E. L. Hepton, carrying on business as brassfounders at Hunslet Lane, Leeds, under the style of William Hepton & Son, has been dissolved so far as concerns Mr. J. W. L. Hepton. Mr. A. E. L. Hepton will continue to carry on the business.

A PETITION for the voluntary winding-up of the Cox Brass Manufacturing Company, Limited, 135, Wellington Street, Glasgow, under the supervision of the Court, has been presented to the First Division of the Court of Session at Edinburgh. Confirmation is also sought of the appointment of Mr. Andrew Pickard Gilmour, 135, Wellington Street, Glasgow, as voluntary liquidator.

THE partnership heretofore subsisting between Messrs. A. P. Hill, of 54, Cambridge Road, Southport, consulting engineer, and J. A. Hill, Sheffield, engineer, carrying on business as engineers and ordnance manufacturers, at Ordnance Works, Sheffield, under the style of J. & P. Hill, has been dissolved. The business will in future be carried on by Mr. J. P. Hill, under the style of J. & P. Hill.

IN connection with the liquidation of Thornewill & Warham, Limited, engineers and ironfounders, Burton-on-Trent, an application was made in the High Court of Justice, on July 6, on behalf of Messrs. Baby, Fell & Company, of Manchester, the largest creditors, for the appointment of Mr. G. G. Poppleton (Poppleton & Appleby), chartered accountants, Birmingham, as joint liquidator. The application was granted.

THE Council of the West of Scotland Iron and Steel Institute have now published the conditions for the award of the "James Riley" medal, to commemorate the election of the first president 21 years ago. The competition will be under the control of the Council, and the medal is to be awarded for the following:—(a) A paper embodying the results of independent study or practice in any branch of the iron and steel industry. (b) An account of an unpublished original research conducted by the writer in connection with the iron and steel industry; or (c) a paper collecting facts concerning the iron and steel industry, not generally known, or presenting them in a new light. The value of the award is £10, and may take the form of (1) the medal in gold, (2) the medal in bronze, and scientific instruments or books, (3) the medal in bronze, and the balance in money to be applied in research. Papers may be submitted by ordinary and associate members of the West of Scotland Iron and Steel Institute, and students of the University of Glasgow, the Royal Technical College, Glasgow, and certain other technical schools in the West of Scotland.

THE Royal tour in Scotland during the early part of July concluded with visits to works in industrial Lanarkshire. On their arrival at the Parkhead Forge, of William Beardmore & Company, Limited, the King and Queen were received by Sir Wm. and Lady Beardmore, and were conducted to a special pavilion within the works. On an adjacent gallery was a group of 60 employers and workmen, representative of the Conciliation and Arbitration Board. Their Majesties signed the visitors' book, and on their tour of inspection the guard of honour was provided by 28 old Army men, all of whom are in the employment of the firm. Among those who accompanied the Royal party through the works were the Duke and Duchess of Montrose, Sir J. Trevor Dawson, the Marquis and Marchioness of Graham, Colonel J. Smith Park, and Lord Provost Sir D. M. Stevenson. Their Majesties first proceeded to the 5,000-ton hydraulic press, where they witnessed the forging of the tube of a 15-in. gun. Rear-Admiral Adair, superintendent of the gun factory, explained the process demonstrated. Many of the ingots

cast at Parkhead are subjected to dynamic compression when the metal is in a fluid state, and this process was demonstrated to the Royal visitors. Their Majesties witnessed the processes of wire winding, and a scale model of a 15-in. gun, measuring five feet long was inspected, and was taken to pieces and reconstructed. The fitting of the breech mechanism was next witnessed, and their Majesties afterwards inspected some large steel castings. Prior to the departure of their Majesties, the following works officials were presented :—Mr. D. Girdwood, secretary; Mr. V. B. Stewart, general manager; Mr. T. H. Lauder, chief engineer; Mr. G. N. Cook, foundry manager; Mr. T. W. M. Jacks, manager of the wheel and axle works; Mr. John Macfarlane, Mr. J. G. Beardmore, Mr. J. C. Smith, Mr. G. T. Neilson, Mr. Thomas Binks, and Mr. D. Robertson. The Royal party also visited the Dalmuir Naval Construction Works, the works of the Fairfield Shipbuilding and Engineering Company, Limited, Messrs. Denny's shipbuilding yard and the Argyll Motor Works.

On Saturday, July 11, the Birmingham Branch of the British Foundrymen's Association accepted an invitation by Messrs. J. W. Jackman & Company, Limited, of the Vulcan Works, Blackfriars Road, Manchester, to visit their works. The party, comprising about 70 members, were met on arrival by Messrs. Arthur Leidig and John Sugden (directors), W. Rawlinson (manager), and H. Warner (commercial representative), and were entertained to luncheon. Afterwards a tour of the works was made, and a number of demonstrations were given, with explanations by Mr. Leidig. Arrangements were also made to give tests and demonstrations of all types of machines under working conditions. The exhibition building has already been described in our columns. The floor is mainly devoted to moulding machines, jarring apparatus, etc., a large recess being occupied by sand-blast machines and air-clearing apparatus, while the balconies and galleries accommodate a large variety of crane and hand ladles. Special attention was directed to a new jolt-ramming moulding machine, which can turn out work up to 8 ft. 6 in. wide. The jolting is by compressed air, about twenty blows being necessary to ram the sand. In this case the pattern was drawn by hand. Another machine was shown in which the pattern was drawn by hydraulic power. It was pointed out that the requirements in the way of machines vary considerably, and the company have therefore furnished a wide selection. A demonstration was given of a new compressed-air machine completed less than 24 hours before the arrival of the party. The machine is furnished with an inner and outer cylinder, which reduces the vibration, and is therefore less disconcerting to the other workers in the same shop. Complete success in the demonstration was marred by the sand not being properly tempered, but the experiment appeared to impress the spectators with the merits of the machine. Microscopes and metallurgical instruments were also exhibited. Before leaving, a hearty vote of thanks, proposed by Mr. Heggie, was accorded the firm and the staff for the information laid before the foundrymen. Mr. Leidig, in acknowledging, expressed his thanks to the members of the staff, who had sacrificed their holiday to assist in making the visit instructive and enjoyable.

Inventions.

Applications for Patents.

An Asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicator are in brackets.

13,240. Furnaces. J. Scott.
13,261.*Reheating-furnaces. O. Schmidt.
13,643.*Process for reducing the sulphur contents of metallurgical coke. R. Fabry.
13,835. Manufacture of steel and iron. C. V. Burton.
13,951.*Electric furnaces for metallurgical purposes. H. Nathusius and Westdeutsche Thomasphosphat-Werke G.m.b.H.
14,003. Reverberatory furnaces. W. A. Russell and J. Lord.
14,039.*Hand moulding machines with lifting arrangement. A. Utard.
14,846. Automatic regulator for admitting a definite and constant supply of air to stoves, furnaces, etc. H. S. F. Warth.
15,084. Manufacture of iron. A. E. Bourcoud.
15,127. Moulding-machines. A. King and J. H. Knott.
15,157.*Methods and means for foundry casting. H. Lowe and E. Brookes, trading as Lowe & Brookes, and W. E. Lowe.
15,219. Reinforcing cast metals, especially applicable to the casting of propeller blades. D. Brown.
15,222. Furnace grates. A. W. Bennis.
15,455.*Electric furnaces. F. J. Machalske.
15,778. Crucible furnaces. A. Ionides, jun.
15,899. Gas-heated crucible furnaces. J. King, J. R. Burnett, and the Richmond Gas Stove & Meter Company, Limited.
15,961. Metals and methods of manufacutring the same. (Aladar Pacz, United States.)
16,171. Process for the removal of phosphorus from iron and steel. S. O. Cowper-Coles.
16,175. Electro-deposition of alloys. S. O. Cowper-Coles.

Abstracts of British Patent Specifications recently Accepted.

12,960 (1913). *Manufacture of Iron and other Metals.* A. E. Bourcoud, 270, Kennington Park Road, London, S.E.—This invention relates to cyclic processes for the manufacture of iron, etc., by circulating gases and regenerating used gas. It is ordinarily found preferable to employ heating stoves of the continuous type, but when the pressure of gases circulating therethrough materially differs from that of the atmosphere leakages are apt to occur, due it may be to porosity of the material of which they are constructed or to defective joints. The invention has for its object parts as will obviate or minimise risk of leakage at the heating stoves. For such purpose the circulators are arranged in conjunction with the regenerator and desulphuriser entirely between the outlet of the heating stove corresponding to the regenerator and the inlet of the heating stove corresponding to the metallurgical furnace, so that the gas can be caused to traverse the regenerator and desulphuriser without the pressure in the heating stoves differing materially from atmospheric.

Protection of Foreign Patents.

Mr. Robert Harcourt has asked the President of the Board of Trade, whether the international convention for the protection of industrial property provided that any application for a patent from a foreign country must be made within 12 months from the date of application for the same patent in that foreign country; whether applications in contravention of that provision were so frequently allowed as to cause it to be practically inoperative; and whether, seeing that parties interested were put to unnecessary expense for revocation proceedings, he would consider an alteration of the law to obviate such difficulties.

Mr. Burns replied that applicants for patents based upon foreign applications who desired to obtain the benefits of the International Convention for the Protection of Industrial Property must make application in the United Kingdom within 12 months from the date of the first foreign application. No exception to this rule was allowed. If an applicant did not desire to avail himself of the benefits of the convention he might make application at any time in the United Kingdom. No alteration of the law in this respect was contemplated.

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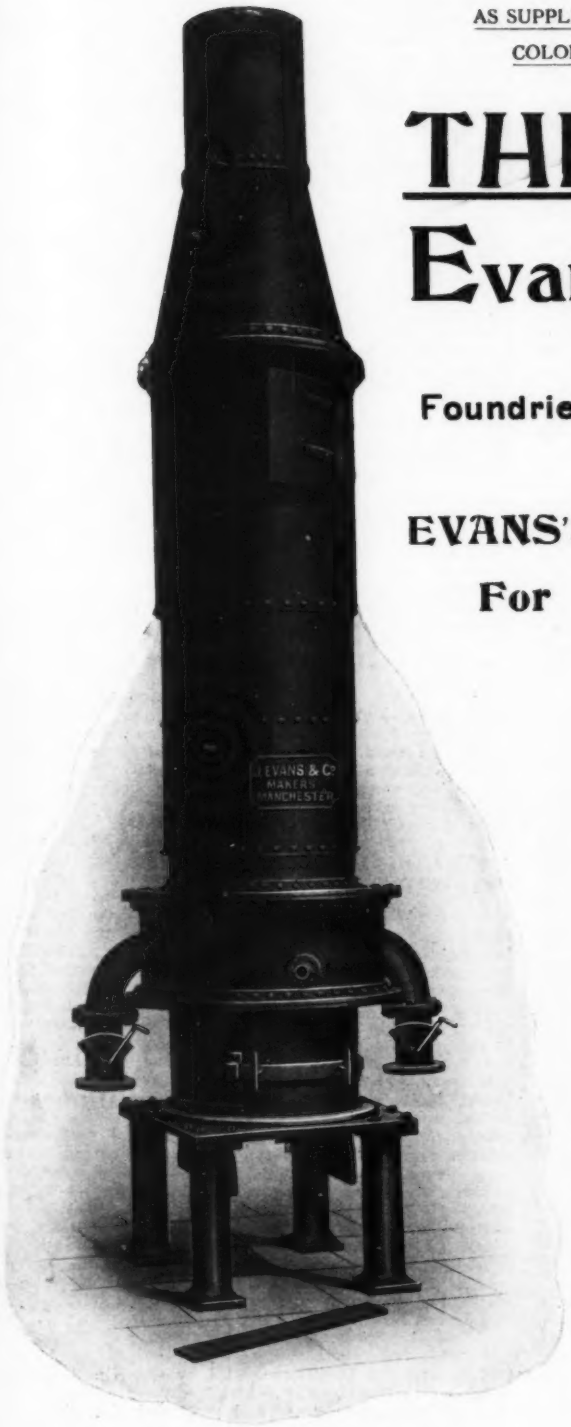
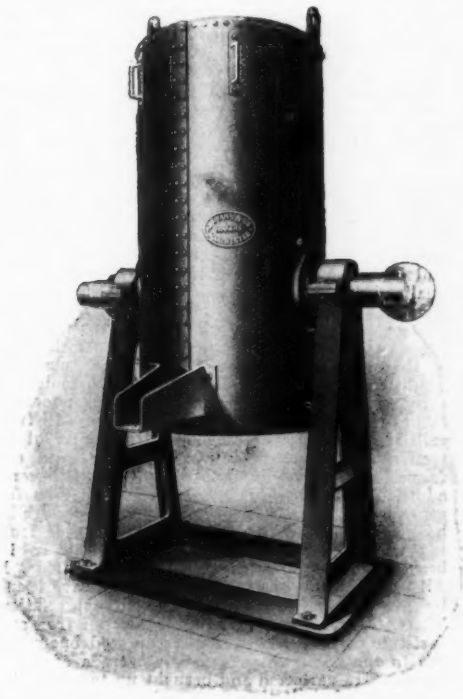
Evans's Rapid.

Foundries Completely Furnished.

EVANS'S NEW CUPOLETTE
For Emergency Work.





James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."
Telephone: 2297 CENTRAL, MANCHESTER.

Deaths.

MR. O. W. ELLIS, a director of Robey & Company, Limited, engineers and boilermakers, Lincoln, died recently.

MR. JAS. HALL, a partner in the firm of James Hall & Sons, Blue Boar Foundry, Rochester, died recently, aged seventy-four.

THE death is reported of Mr. A. B. Brown, who was associated with the business of Thos. B. Brown, of the Tiel Engine Works, Fergus Wynd, Kirkcaldy. He was 76 years of age.

THE death is announced from Baden Baden, at the age of 56 years, of Herr Gustav Halbach, the technical director of the Gesellschaft für Stahl Industrie, of Bochum, Germany.

MR. N. S. ROBERTS, third son of Mr. Samuel Roberts, M.P., a director of Cammell, Laird & Company, Limited, and J. Grayson, Lowood & Company, Limited, died on July 19 at his home at Ebbw Vale, South Wales. The deceased gentlemen, who was 26 years of age, held an assistant managerial position under the Ebbw Vale Company.

THE death is announced at the age of 73 of Mr. T. T. Fisher, of Lawnside, Hagley. Mr. Fisher had been connected with the iron trade all his life, and was a well-known figure throughout South Staffordshire. At one period he was associated with the firm of John Russell & Company, Limited, of Walsall and Birmingham. For many years he had been a Justice of the Peace for the county of Stafford.

WE regret to announce the death of Mr. James M. Swank, of Philadelphia, U.S.A., at the age of 82 years. The deceased gentleman, it will be remembered, retired from the position of general manager of the American Iron and Steel Association about 18 months ago. He was the Nestor of the American iron and steel industry, and by his death the trade has lost a unique champion. In fact his work was the foundation of statistical information in the States, and the accuracy of his compilations were never questioned. His early life was devoted to journalism. In 1869, however, he went to Washington for three years, first as clerk of the Committee on Manufactures of the House of Representatives, and afterward as chief clerk of the Department of Agriculture. In December, 1872, he resigned his last-named position to take charge of the work of the American Iron and Steel Association, which has always had its office in Philadelphia. Mr. Swank was specially qualified for his duties in charge of the affairs of the Association. Being a journalist by profession, he thoroughly understood the work of preparing and printing the various publications of the association, while at the same time he was familiar with manufacturing conditions and was an ingrained protectionist. In the early years of his connection with the Association the tariff question was prominent, and he was frequently called upon to prepare arguments in favour of the protective policy and to furnish statistical and other information to protectionist members of Congress. In addition to this work, Mr. Swank found time for more general literary achievements. In 1878 he published in book form an "Introduction to a History of Iron Making and Coal Mining in Pennsylvania." In 1891 he brought out his most ambitious work entitled "Iron in All Ages," while numerous other works have been issued by him from time to time. In an appreciation, Mr. W. G. Gray, statistician to the American Iron and Steel Institute, says that Mr. Swank devoted one-half of his life to the up-building of the iron trade of the United States. He perfected and brought up to a high standard the work of collecting full and complete statistics of the industry. The Annual Statistical Reports of the Association, of which 40 had been issued down to the time he retired as vice-president and general manager, are models of statistical accuracy and thoroughness. He originated the Directory to the Iron and Steel Works of the United States, and personally supervised the compilation and publication of 17 editions of this book, together with five supplements.

WE regret to announce the death of Mr. Thomas Richard Bayliss, which took place at his residence, Belmont, Northfield, on July 2, at the age of 76. The deceased, who was the chairman of the King's Norton Metal Company, Limited, had been in ill-health for about two years. Born in Birmingham, in 1838, the eldest son of Mr. Thomas Bayliss, a well-known brass-founder, he received his education at one of the branch schools of King Edward's Foundation. Early in his teens he decided to make engineering his profession, and devoted himself to the study of theoretical and practical engineering and metallurgy. At the age of 24 he married the daughter of Mr. John Abraham, who founded the Adderley Park Mills. That property was disposed of by his father-in-law about ten years later to the Birmingham Small Arms and Metal Company, and Mr. Bayliss remained at that establishment as its managing director. He held the position till 1889, when, in conjunction with his son, Mr. T. A. Bayliss, he commenced the erection of a large works at King's Norton, now known as the King's Norton Metal Works. Some few months after its establishment he called in his friend, the late Mr. Arthur Greenwood, then chairman of Greenwood & Batley, Limited, the well-known cartridge machinery manufacturers, of Leeds, and with his assistance, the concern was formed into a limited liability company, of which both father and son were joint managing directors. The company has enjoyed a career of steadily increasing prosperity, and, we might say, peculiar and unique popularity. Thus has been built up one of the most extensive and interesting businesses in the country. Mr. Bayliss had given himself a thorough training in mechanical engineering, and he displayed considerable ingenuity in perfecting machines designed to improve the methods of casting, rolling and general working up of metals, particularly for ammunition work, which has become a leading department in the business of the company. Mr. Bayliss was the original inventor of the solid-drawn cartridge case for small arms, quick firing and other guns, etc., since utilised for all the armies and navies of the civilised world. In this connection he was called in by Mr. Thorsten Nordenfelt to manufacture a suitable cartridge for his six-pounder gun, which made both gun and cartridge a complete success, and they were immediately adopted by the British Government. It is interesting to place on record that after the Franco-German War Mr. Bayliss went over to Spandau, Erfurt, and Danzig to superintend and erect plant for the production of the then new design of solid drawn small-arm cartridge cases for the Imperial German Government. Under the direction of Mr. Bayliss and his colleagues the works at King's Norton were splendidly equipped, the plant including complete provision for the production of coinage. The contracts for ammunition executed by the company have included large orders not only from the British but also from several foreign Governments, amongst which may be mentioned the Japanese, Swedish, Danish, Italian and Spanish. Some years ago 60 acres of land were acquired at Abbey Wood, Kent, and on this site an important extension of the works was erected, especially for loading large cases and shells, fuzes, etc. The deceased gentleman was the recipient of many professional honours. He was a member of the Iron and Steel Institute, an associate member of the Institution of Civil Engineers, and a member of the Institution of Mechanical Engineers. He was also a member of the French Société des Ingenieurs Civiles, of the American Academy of Political and Social Science at Philadelphia, a fellow of the Imperial Institute as at first constituted, and one of the first members of the Permanent International Association of Navigation Congresses.

THE works at Preston occupied by the Gillett Street Engineering Company (Preston), Limited, together with the motive power (steam and gas), and the whole of the fixed machinery, plant, and appliances have been put up for sale by auction. Bidding commenced at £1,800, and rose to £2,100 at which price it was withdrawn.

Personal.

THE late Mr. J. A. Macdonald, managing director of Markham & Company, Limited, left £6,590 gross, and £6,475 net.

THE late Mr. J. R. Crosthwaite, of Messrs. J. R. Crosthwaite & Company, Union Foundry, Thornaby, left £45,235.

THE COUNCIL OF THE UNIVERSITY OF LIVERPOOL have conferred on Mr. T. F. Wall, D.Sc., the degree of Doctor of Engineering.

MAJOR-GENERAL EDWARD MICKLEM is retiring during the present year from the chairmanship of Greenwood & Batley, Limited.

THE Admiralty have appointed Mr. J. A. Lavender Senior Assistant Analyst on the staff of the Inspector of Steel, Sheffield.

THE late Mr. J. Cliff, a director of the Frodingham Iron and Steel Company, Limited, left £233,206 gross, and £156,383 net.

MR. G. RHODES, a director of Burys & Company, Limited, Regent Works, Penistone Road, Sheffield, has been appointed Recorder of Oldham.

MR. THOMAS FERLIE, ironfounder, Auchtermuchty, and Mr. James Martin, iron founder, Charlestown, have been appointed Justices of the Peace.

THE late Mr. Thomas Miller, engineer and iron founder, of London Road, Edinburgh, left personal estate in the United Kingdom valued at £138,686.

THE late Mr. J. Howden, of James Howden and Company, Limited, engineers and boiler makers, Glasgow, left personal property of the value of £388,251.

ESTATE of the gross value of £18,769 has been left by the late Mr. Samuel Marsden, chairman and managing director of Samuel Marsden & Son, Limited, engineers, of Manchester.

MR. R. HAMILTON, stores manager to the Dalmellington Iron Company, Limited, has been the recipient of a presentation on his departure to fill the position of storeh manager with William Baird & Company, Limited, Gartsherrie.

THE Keith prize of the Royal Society of Edinburgh has been presented to Mr. James Russell for his series of investigations relating to magnetic phenomena in metals and the molecular theory of magnetism.

MR. LIONEL HANBURY has retired from the board of Crompton & Company, Limited, engineers and brassfounders, Chelmsford, Essex. The Hon. Sir Charles A. Parsons, K.C.B., has been elected a trustee for the debenture holders in the place of the late Sir Charles D. Rose, Bart.

MR. J. DICKINSON, secretary and manager of the North Lonsdale Iron and Steel Company, Limited, has decided to retire. Mr. E. L. Tosh, furnace manager for some years, has been appointed general manager, Mr. Jno. Knight, secretary, and Mr. W. H. Holden will have charge of the sales department.

MR. WILLIAM DARBY, iron and steel merchant, of Edgbaston, has been made a J.P. for Birmingham. A similar distinction has been conferred upon Mr. A. G. Ellaway, brassfounder, Moor Green; Mr. G. H. Ingall, a director of Ingall, Parsons, Clive & Company, Limited, brassfounders, Birmingham; and Mr. A. D. Matthews, brassfounder, Harborne, a member of the Conciliation Board in the brass trade. Mr. Matthews rendered useful service in bringing into operation the scheme for grading the brassworkers.

New Companies.

Universal Engineering Company, Limited.—Capital £25,000 in £1 shares.

General Engineering Accessories, Limited.—Capital £1,000 in £1 shares.

Pougher & Company, Limited.—Capital £1,000 in £1 shares, to carry on the business of engineers.

Lang & Lang, Limited.—Capital £1,000 in £1 shares, to carry on the business of iron manufacturers.

Reece Machinery Company, Limited.—Capital £10,000 in £1 shares, to carry on the business of engineers, founders, etc.

Morgan Crucible Company (Italy), Limited.—Capital £2,000 in £10 shares. The first directors are K. V. Morgan, L. A. Trapmann, and S. Beeton.

John Phillips (Brass Foundry and Lamp Company), Limited.—Capital £4,000 in £1 shares. The first directors are J. Phillips and Mrs. C. I. Phillips.

Challoners, Limited.—Capital £6,000 in £1 shares, to carry on the business of engineers, etc. The secretary is J. W. Haigh. Registered office: 72, Albion Street, Leeds.

Clan Foundry Company, Limited.—Capital £4,000 in £1 shares, to take over business of general ironfounder, etc., carried on by A. F. Richards at Queen Street, Belper, Derby, as the Clan Foundry Company.

Nichols Pump & Engineering Company, Limited.—Capital £7,500 in £1 shares, to take over business of pump makers and general engineers carried on by T. W. Nichols and W. W. Nichols, at Oakwellgate, Gateshead, Durham, as Nichols Brothers.

G. A. Joyce & Company, Limited.—Capital £5,500 in £1 shares, to carry on the business of ironmasters, etc. The first directors are G. A. Joyce (managing director), J. Fouldes, and T. J. Fouldes. Registered office: 40-44, Holborn Viaduct, London, E.C.

T. McDougall & Company, Limited.—Capital £5,000 in £1 shares, to carry on the business of manufacturers of steel and steel specialities, etc. The first directors are J. M. Lochhead and W. Kay. Registered office: 161, Finnieston Street, Glasgow.

Walco, Limited.—Capital £2,000 in £1 shares (1,950 preference), to carry on the business of manufacturers of pattern requisites, etc. The first directors are C. L. Waltner, C. J. Robertson, and J. R. Jennens. Registered office: 66, Slavey Street, Birmingham.

D. Fullerton & Company, Limited.—Capital £10,000 in 3,000 preference and 7,000 ordinary shares of £1 each, to acquire and carry on the business of D. Fullerton & Company, ironfounders, forgers, engineers, etc., Johnstone. The first directors are J. Rutherford and J. Dickie.

Grahamston Iron Company, Limited.—Capital £70,000 in £10 shares, to acquire and carry on the business of the Grahamston Iron Company. The first directors are J. Mitchell, W. W. Mitchell, W. T. Mitchell, and T. Downie. Registered office: Gowan Avenue, Grahamston, Falkirk.

Cardon & Company, Limited.—Capital £4,100 in £1 shares (4,000 preference), to carry on the business of manufacturers of fencing, iron and steel founders, etc. The first directors are H. A. Cardon (permanent) and J. H. Mann. Registered office: 61, Chancery Lane, London, W.C.

Carlton Iron Company, Limited.—Capital £325,000 in £1 shares (125,000 5 per cent. cumulative preference), to acquire the existing undertaking of iron and coal masters, steel converters, blast furnace proprietors, etc. The first directors are W. Morrison, W. McGowan, J. McGowan, and W. Thomlinson.

James Whitfield, Limited.—Capital £20,000 in £1 shares (6,000 preference), to take over the business of brassfounders carried on by J. Whitfield, E. J. Collins, and P. Whitfield at 38 & 39, Oxford Street, Birmingham, as James Whitfield. Registered office: Anchor Works, 38 & 39, Oxford Street, Birmingham.

Philip Jenkins' Sons, Limited.—Capital £30,000 in £10 shares, to acquire the business of J. E. Jenkins and others, brassfounders and metal merchants, carried on by them at Neath, Glamorgan, as Philip Jenkins' Sons. The first directors are R. Y. Jenkins, I. O. Jenkins, J. E. Jenkins, W. J. Jenkins, P. H. Jenkins, and D. T. Jenkins (all permanent). Registered office: Riverside, Neath, Glamorgan.

Mond Nickel Company, Limited. — Capital £1,700,000, in £1 shares (500,000 7 per cent. cumulative preference, 300,000 non-cumulative preference and 900,000 ordinary), to adopt an agreement, dated July 22, 1914, with the Mond Nickel Company, Limited (incorporated in 1900) and R. Mathias, the liquidator; to search for, win, etc., nickel, copper and other ores, and ore, metal and mineral substances, etc. Purchase consideration, £2,075,000 (£7 cash, £1,699,993 shares and £375,000 debenture stock). No separate amount is provided in the last balance-sheet of the old company for goodwill. The above-mentioned £375,000 debenture stock and £1,699,993 shares are receivable by the debenture stock and share holders in exchange for their holdings in the said old company. The first directors (to number not less than four nor more than 15) are:—The Right Hon. Sir Alfred Mond, Bart., P.C., M.P., Carl Langer, Ph.D., Ynyspenllwch, Clydach, Mon.; R. Mathias, B. Mohr, E. S. Mond, R. L. Mond, Sir Andrew Noble, Bart., K.C.B., F.R.S., Jesmond Dene House, Jesmond Dene, Newcastle; S. W. A. Noble and Sir Edmund Walker, C.V.O., LL.D., Canadian Bank of Commerce, Toronto. Registered office: 39, Victoria Street, Westminster.

The "Rennerfelt" furnace, which is one of the most recent types of electric furnaces designed, is making considerable headway in this country. Although only invented early in 1912, after which some time was taken up with the necessary trials, there are now erected and on order 20 of these furnaces. Within the four months that the furnace has been on the British market, three firms have placed orders. Within the next two or three weeks one of these furnaces will be in operation at a large steel works in Sheffield, and shortly afterwards two more will be in operation in the vicinity of Birmingham, for the manufacture of high-class castings. The furnace may be likened to a large crucible, from which all air is excluded, and tests have shown that the amount of electric current used is much less than is usually the case. The furnace is being handled in this country by the International Engineering Company, of Prudential Buildings, Sheffield.

FANS AND BLOWERS AND OTHER FOUNDRY MACHINERY FOR SALE.

BARGAINS FOR PROMPT CASH.

No. – Root's Blower "Acme" for 20 smiths' fires.
One ditto, with high-speed Vertical Engine combined.
Thwaites Roots Blower, 11½" discharge.
"B" Roots Blower by Alldays.
Foundry Blowing Fan, 36" impeller, 19" discharge, also 9½" round outlet to fit on same.
14" Schiele patent Blast Fan.
Lloyd's patent Blowing Fan for 50 smiths' fires.
New Roots pattern Blower, 5".
Silent Blowing Fans, 8½", 8" and 9" discharge.
Ball Mill, with drum, 2' 7" and 5' 8" outside by 1' 7" wide.
Improved Foundry Core Ovens, portable type and for fixing in wall.
4' 6" diameter UNDERGEARED LOAM MILL, with stationary pan.

CHARLES D. PHILLIPS,

EMLYN & CENTRAL ENGINEERING WORKS, NEWPORT, MON.

BLOFIL

THE

IRON CEMENT

(Quick or slow setting grades)

IS

THE CHEAPEST

AND

MOST RELIABLE

for all purposes.

Unaffected by oil, steam, or water.

Sole manufacturers—

RUDD & OWEN

Telegrams "Theripnene," Hull.

(DEPT I)

HULL

Telephone National 1223.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,

FIRE CLAY.

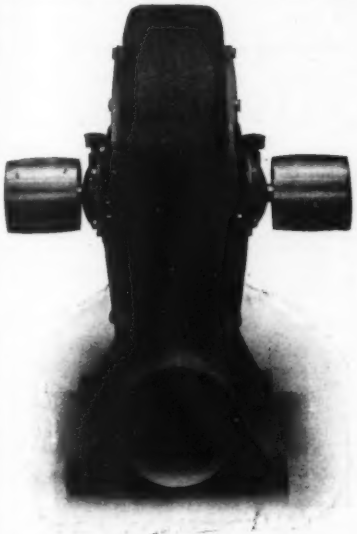
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,

DEEPCAR, nr. SHEFFIELD.

Telegrams: "LOWOOD, DEEPCAR."



TRADE SIROCCO MARK

CUPOLA FANS.

Made in eight sizes from 10-in. to 35-in. diameter, and suitable for melting ½ to 20 tons per hour at pressures from 12—30 inches Watergauge.

Cast Iron Casings and Ball Bearings.

Double Inlet. All Types of Discharge.

Write for Bulletin No. 2028F.

DAVIDSON & CO., LIMITED,

Sirocco Engineering Works,

BELFAST.

ELDERS FOUNDRY COKE

AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using you F undry Coke for several years for special purposes with highly satisfactory results.

Elders Collieries, Ltd., Cardiff.

Telegraph : ELDER, CARDIFF. Telephone : 4640 and 4641.

MONTHLY PRICE LIST.

The undermentioned prices, unless otherwise specified, are those obtaining on the first day of the current month.

Pig-Iron.

Cleveland.

	July 30. s. d.
Cleveland No. 1	53 9
,, No. 3	51 3
,, No. 4 foundry	51 0
,, No. 4 forge	50 6
,, Mottled	50 3
,, White	50 0
East Coast hematite, mixed Nos.	59 0
Cleveland warrants	51 1

Above prices are for early f.o.b. deliveries, and as regards Cleveland iron are for G.M.B. brands. The warrant quotations are the sellers cash prices.

Scotland.

	s. d.
Standard Foundry (Glasgow Market settlement price)	50 7½
Warrants, ditto	57 0

Makers' prices:—	s. d.		s. d.
Gartsherrie No. 1	66 6	No. 3	61 6
Coltness No. 1	—	No. 3	—
Summerlee No. 1	66 6	No. 3	61 6
Langloan No. 1	66 6	No. 3	61 6
Calder No. 1	66 6	No. 3	61 6
Clyde No. 1	66 0	No. 3	61 0
Carnbroe No. 1	65 6	No. 3	59 6
Monkland No. 1	61 0	No. 3	60 0
Shotts No. 1	66 6	No. 3	61 6

(All deliverable alongside Glasgow.)

Glengarnock	No. 1 70 0	No. 3	65 0
Eglinton	No. 1 60 0	No. 3	59 0

(All deliverable alongside Ardrossan.)

Dalmellington	No. 1 61 0	No. 3	59 0

(Deliverable alongside Ayr.)

Carron	No. 1 67 0	No. 3	62 0

(F.a.s. Grangemouth.)

Lancashire.

	s. d.	s. d.
Lancashire No 3 foundry f.o.t.	—	55 0
Lincolnshire No. 3 foundry	—	55 0
Derbyshire No. 3 foundry	—	56 0
Staffordshire No. 3 foundry	—	55 6
Cleveland No. 3 foundry	60 0	60 8

(All delivered equal Manchester.)

Scotch No. 3			
Gartsherrie	66 6	67 0
Glengarnock	65 0	67 6
Eglinton	—	64 0
Summerlee	66 0	66 6

(Delivered Manchester Docks.)

North-West of England.

	s. d.	s. d.
Bessemer mixed numbers net f.o.b.	64 0	65 0
Hematite warrant net cash	—	61 0
Lorn cold-blast charcoal iron	—	200 0

The Midlands.

	s. d.	s. d.
Staffs. Common forge	48 6	49 6
Staffs. Part Mine forge	51 0	52 0
Staffs. Best All Mine	85 0	90 0
Staffs. Cold Blast	—	125 0

Strong forge, about 1s. less than grey forge; Mottled and White, about 2s. less than forge; Foundry No. 3, 3s. to 5s. above forge; No. 1 and No. 2, from 1s. 6d. to 2s. above No. 3; No. 1, about 2s. above No. 2.

Northampton foundry	51 0	51 6
North Staffs. foundry	61 0	62 0
Derby foundry	58 0	59 0
Nottinghamshire foundry	66 0	67 0
Leicestershire foundry	—	59 0
Shropshire Cold-Blast	—	125 0

(Delivered South Staffordshire Works, net cash monthly.)

Lincolnshire.

	s. d.	s. d.
Forge	—	49 0
Grey forge	—	49 0
Basic	50 0	51 0
No. 3 foundry	50 0	51 0
No. 4 foundry	49 6	50 0

F.o.t. Makers' works.

South Wales.

	s. d.	s. d.
Welsh Hematite	62 6	63 6

Ferro-Alloys.

Net, Delivered Sheffield Steel works.

	£ s. d.	£ s. d.
Ferro-chrome: 4/6% carbon. Basis 60%, scale 10s. per unit. Per ton	21 0 0	
Ferro-chrome: 6/8% carbon. Basis 60%, scale 10s. per unit. Per ton	19 0 0	
Ferro-chrome: 8/10% carbon. Basis 60%, scale 8s. 6d. per unit. Per ton	17 15 0	
Ferro-chrome · Specially refined, guaranteed maximum 2% carbon, broken to small pieces for use in best quality crucible steels. Basis 60%, scale 22s. per unit. Per ton	49 15 0	
Ferro-vanadium: 33/40% Va., per lb. of Va. contained in the alloy	0 10 0	
Ferro-silicon: 45/50%. Basis 50%, 5s. scale per unit	Per ton 10 15 0	
Ferro-titanium: 15/18%, per pound, flat	0 0 6½	
Ferro-molybdenum: 70/80% Mo. per pound of Mo. contained	0 10 9	
Ferro-phosphorus: 20/25%. Per ton	13 10 0	
*Ferro-manganese 80%	9 0 0	
,, export	8 5 0	8 10 0

* F.o.b. Liverpool.

Iron Castings.

Cleveland.

	£ s. d.	£ s. d.
Columns (plain)	7 7 6 to	7 12 6
Pipes, 1½ to 2½ in.	6 2 6	6 7 6
,, 3 to 4 in.	5 15 0	5 17 6
,, 5 to 8 in.	5 10 0	5 12 6
,, 10 to 16 in.	5 14 6	—
,, 18 to 24 in.	5 12 6	—
Chairs	4 5 0	4 6 0
Floor plates (open sand)	3 10 0	3 12 6

(At works.)

Non-Ferrous Metals.

Copper.

	£ s. d.
Standard, Cash	56 10 0
Three months	58 0 0
Electrolytic	59 15 0
Tough	61 15 0
Best selected	61 15 0

Tin.

	£ s. d.
Standard, Cash	132 0 0
,, Three months	135 0 0
English Ingots	137 0 0
Bars	138 0 0
Refined	140 10 0

Spelter.

	£ s. d.
Silesian	21 10 0
Specials	22 17 6
Hard	19 5 0
British	22 15 0

Lead.

	£ s. d.
Soft foreign	18 15 0
English	19 5 0

Antimony.

	£ s. d.	£ s. d.
Regulus	26 0 0	to 28 0 0

Aluminium.

	£ s. d.
Virgin Metal, 98/99%	per ton 85 0 0

*Chromium (Metallic).

	£ s. d.
98/99% purity	per lb. 2s. 4½d. to 0 2 6

*Nickel.

	£ s. d.
In cubes, 98/99% purity	Per ton 169 0 0

*Tungsten Metal Powder.

	£ s. d.
96/98% purity	per lb. 0 2 4½

*Molybdenum Metal.

	£ s. d.
96/98% purity	per lb. 10s. 6d. to 0 11 0

*Cobalt Metal.

	£ s. d.
97% purity	per lb. 6s. 9d. to 0 7 0

Quicksilver.

	£ s. d.
75 lb. bottle	6 15 0

* Net, Delivered Sheffield Works.

Scrap Iron and Steel.

Cleveland.

	s. d.	s. d.
Steel scrap, heavy melting	44 0 to	45 0
Iron scrap cast (cupola metal)	50 0	52 6

London (f.o.b.).

	s. d.
Heavy steel	42 0
Light ,,	34 0
Heavy cast	46 0

Non-Ferrous Scrap.

London merchants quote, delivery free, and subject to market fluctuations:—

	J. B. Garnham and Sons. £ s. d.	A. Joseph. £ s. d.
Brass	37 0 0	38 10 0
Clean copper	53 0 0	50 0 0
Brazlery copper	47 0 0	45 0 0
Old lead	17 0 0	18 0 0
Tea lead	—	16 10 0
Old zinc	16 0 0	16 0 0
Hollow pewter	80 0 0	100 0 0
Black pewter (shaped)	60 0 0	65 0 0
Gun metal	49 0 0	49 0 0
Aluminium (cast)	—	—
,, (cuttings)		62 0 0

Stocks.

Pig-Iron in Public Store.

	July 30. Tons.	Inc. + or Dec. — since July 31, 1913. Tons.
Connal's at Glasgow Scotch	1,000	No change.
Ditto other makes	2	−63
Connal's at Middlesbrough	82,815	− 111,489
Connal's at Middlesbrough hematite	—	No change.
West Coast hematite	4,096	−17,627

Metals.

Copper, Europe and afloat	—	—
Tin, London, Holland, U.S.A. and afloat	16,661	+2,948

Coke.

Middlesbrough.

	s. d.	s. d.
Gas Coke	— to	11 6
Foundry Coke	—	19 0
Furnace coke	—	17 6

Newcastle-on-Tyne.

	F.o.b. Dunston. s. d.
FOUNDRY COKE—	
Original Garesfield	20 6
Mickley	19 6
Stella Garesfield	20 0
Priestman's Garesfield	20 6
Consett Garesfield	20 6
Newcastle gas coke	13 0

Cardiff.

	s. d.	s. d.
Special foundry coke	25 0 to	29 0
Foundry coke	20 0 to	23 0
Furnace coke	17 0 to	19 0

Leeds.

Furnace coke	10 3 at ovens.

Birmingham.

	s. d.	s. d.
Foundry coke	31 0 to	37 6
Furnace ,,	14 0 to	17 6
Gas ,,	14 0 to	15 0

Glasgow.

	s. d.	s. d.
Foundry coke	—	27 0
Furnace ,,	—	18 0
Gas ,,	—	10 6

London.

	s. d.	s. d.
Foundry coke	27 0 to	28 0
Gas ,,	16 8 to	18 4

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.

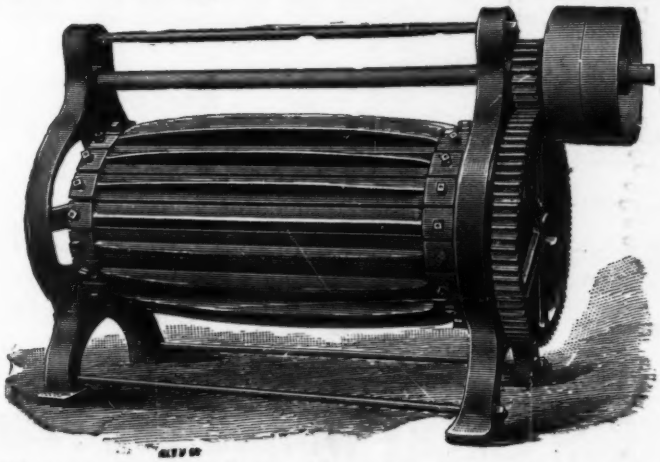
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



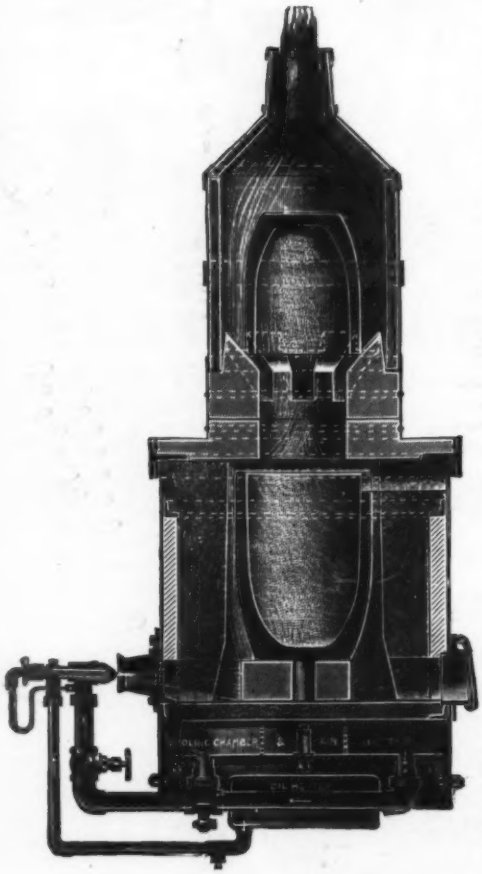
These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

SIX REASONS for using
The "BUESS" Oil-Fired Crucible Melting Furnace.



1. Low Oil Consumption, about 8%
2. Rapid Melting.
3. Use of Thick Crude Oils.
4. Heating of Air and Oil in the Furnace before reaching Burner.
5. Long Life of Crucible and Lining.
6. LOSS in MELTING about 0.5%.

There are others; write us for special leaflet and time sheets.

The **"BUESS"** line of furnaces covers Stationary and Tilting types, Rolling Furnaces for melting steel, malleable and gray iron, Portable Furnaces, White Metal Melting Furnaces, Oil-fired Core Ovens, Ladle Heaters, Cupola Lighters, etc., etc.

THE LONDON EMERY WORKS Co., PARK WORKS,
TOTTENHAM, LONDON, N.

Nearest Passenger Station, Park, G.E.R. Telephone: Tottenham 158.

SITUATIONS VACANT AND WANTED.

WANTED, AGENTS calling upon Ironfounders, to introduce "Shally's Steel Wire Brushes." Good commission to suitable men with connections.—Write SHALLY & Co., Wire Brush Manufacturers, 55, Great Thornton Street, Hull.

WANTED, in small Iron and Brass Foundry in Midlands, a thoroughly experienced Working Moulder, as FOREMAN. Must be 6 o'clock man, and willing to take an active interest in the prosperity of the business, if can invest £100 or £200 preferred.—Apply, full particulars, Box 528, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FOR SALE AND WANTED.

CORE GUM. ROSIN. CORE GUM. ROSIN.

IT will Pay you to write me for Samples and Prices. EDGAR KENYON, Direct Importer.

5, Carr Street, Blackfriars Street, Manchester.

HALL'S INVINCIBLE SAND MIXERS are now successfully in use for preparing NEW SANDS and UTILIZING OLD SANDS in some of the LARGEST FOUNDRIES.—Write for information and prices to C. E. V. HALL, Paradise Chambers, Sheffield.

PLATING HAMMER, 5 cwt., by Alldays, recently overhauled. Inspection invited.—Box 532, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FOR SALE AND WANTED—(*Continued.*)

ROOTS BLOWER, Allday's No. 4, capacity 4,690 c. ft. per minute. Condition equal to new. £48.—Box 531, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

NEW FOUNDRY OLDHAM.

EXCELLENT OPENING for an up-to-date and LARGE FOUNDRY in the Oldham district. 50 to 100 tons of orders per month could no doubt easily be procured by Engineering Firms in the locality.—Application for further particulars, Box No. 520, Offices of THE FOUNDRY TRADE JOURNAL, 165 Strand, London, W.C.

JOHN WILLIAMS (BIRMINGHAM SAND), Ltd.,

ICKNIELD SQUARE WHARF, BIRMINGHAM.

ESTABLISHED OVER A CENTURY.

SUPPLY

FOUNDRY SAND

To the Requirements of all Users.

Also ROLL SAND of all descriptions ready for use.

Telegrams: "Logic, B'ham." Telephone: Midland 1816.

USE THE "OXY-ACETYLENE" PROCESS

For the repairs of your faulty Castings.

Makers of Complete Plants. **McGOWAN, WILD & COMPANY,**

206, Hurst Street, Birmingham.

FRODAIR

SPECIAL PIG IRON

for

CYLINDERS, CHILLED CASTINGS, MACHINE CASTINGS, and any :: :: FOUNDRY PURPOSE. :: ::

ASK FOR OUR SUGGESTIONS FOR ECONOMICAL IRON MIXTURES.

THE FRODAIR IRON & STEEL CO., LTD.,

Fenchurch House, LONDON, E.C.

WHITE METAL LETTERS

Stamped Brass Letters.

All kinds of Letters for Pattern-making and Foundries supplied from stock at very advantageous prices.

Solid (cast) Brass Letters.

Walton & Co.,

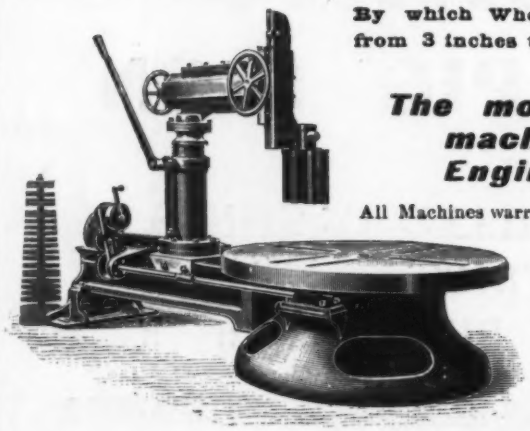
66-68, Slaney Street,

Birmingham.

38¼"
McNEIL'S
PATENT UNBREAKABLE
STEEL LADLES
These Ladles are manufactured by a patented process, each from a single steel plate without weld or rivet. They are extremely light, being at the same time the strongest and most durable in the market. Ladles to contain 56 lb. of metal only weigh about 7 lb. each. They are made of all capacities from 30 lb. to 60 cwt., with or without lips; also mounted or unmounted. They are also suitable for chemical and metallurgical processes. List of sections and prices on application to
CHAS. McNEIL.
KINNING PARK IRONWORKS,
GLASGOW.
36"
32½"

Can also be made in Aluminium.

WHITTAKER'S IMPROVED MOULDING MACHINE



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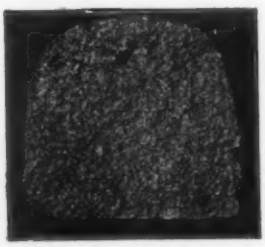
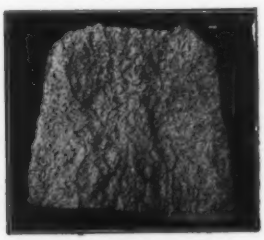
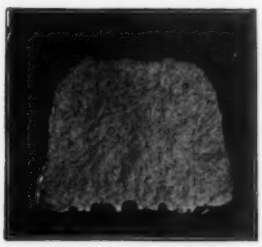

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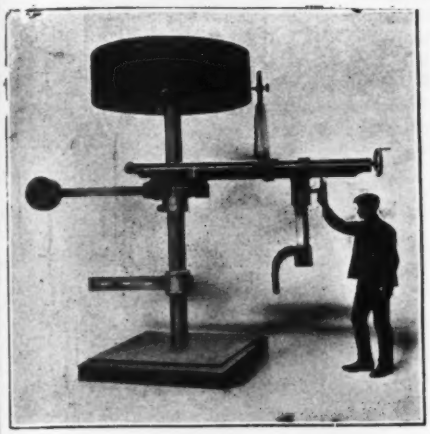

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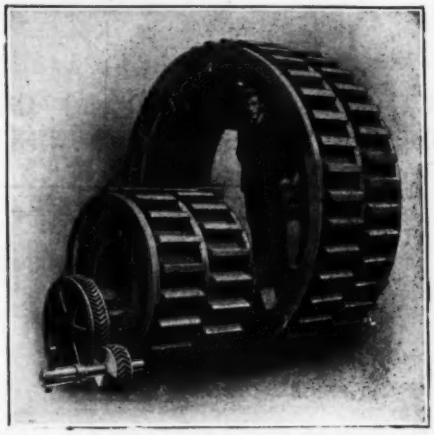

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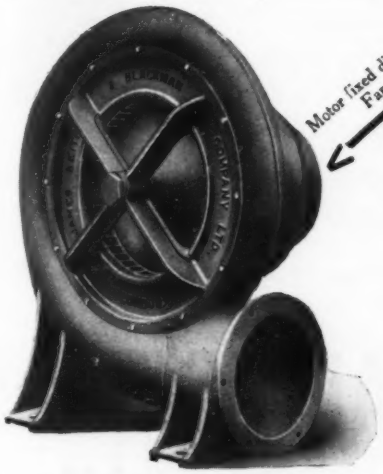

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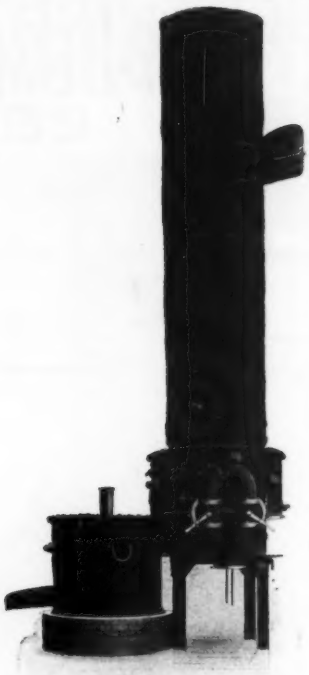

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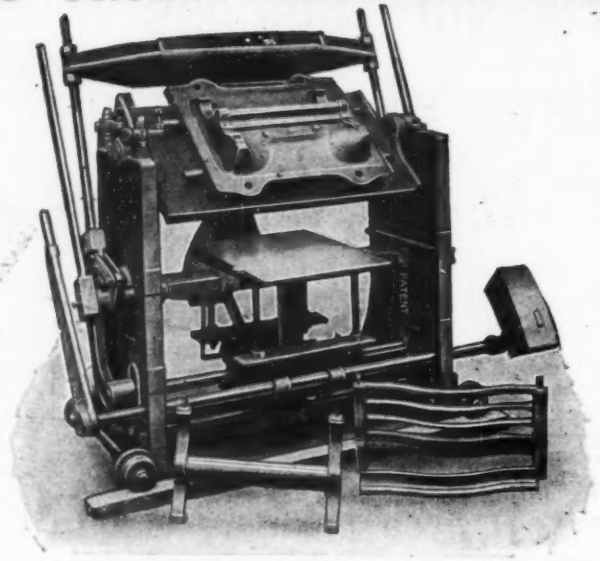

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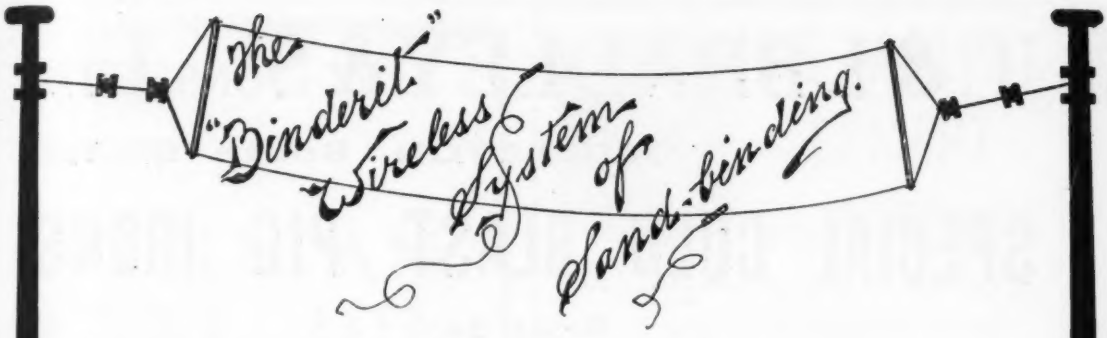

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